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REPORT

REVIEW of RI/FS WORK on the ACME SOLVENTS SITE

ACME TECHNICAL COMMITTEE

JUNE 1985

EUGENE A. HICKOK AND ASSOCIATES

REVIEW OF THE RI/FS REPORT
ON THE ACME SOLVENTS SITE

FOR THE

ACME TECHNICAL COMMITTEE

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JUNE 1985

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PART ONE

QA/QC PROGRAM REVIEW

REVIEW OF QA/QC PROGRAM FOR
REMEDIAL INVESTIGATION OF ACME SOLVENTS DISPOSAL SITE

1.0 INTRODUCTION

Quality assurance/quality control (QA/QC) programs in connection with site remedial investigations aim to provide monitoring and measurement data of adequate quality for decision-making. Data quality is described in terms of precision, accuracy, completeness, representativeness, and comparability (U.S. Environmental Protection Agency, 1980 and 1984).

The feasibility study currently under review for the Acme Solvents disposal site near Rockford, Illinois (E. C. Jordan Co., November 1984) is based primarily on data reported in a companion remedial investigation (E. C. Jordan Co., September 1984). A separate document entitled, "Quality Assurance Project Plan (OAPP) for Remedial Investigation/Feasibility Study for the ACME Solvent Superfund Site" (E. C. Jordan Co., January 1984) describes the planned OA/QC program related to these studies.

As charged by the Technical Committee, E. A. Hickok and Associates has reviewed the above documents and additional related documents to assess the adequacy of the cited OA/QC program. The following sections of this memorandum summarize our review. Significant shortcomings are identified.

2.0 QUALITY ASSURANCE PROJECT PLAN

The laboratory OA/QC procedures are described in detail. Figure 1.1 shows a table excerpted from the QAPP that outlines the project's quality assurance objectives. Of particular relevance are the objectives for precision and accuracy, stated as plus-or-minus a given percentage of the mean or true value for a set of measurements.

Precision gauges the reproducibility of repeated measurements within narrow bounds. For both water and solids data, the stated precision objective for organic Priority Pollutants is ± 30% (see Figure 1.1). A way of interpreting this objective is as an outer limit on the standard deviation of repeated measurements.

Thus, a set of repeated measurements with a standard deviation of 25 (percent of the true value or mean) would fulfill the objective, while one with a standard deviation of 35 would not.

Accuracy describes the achievement of measured values that are close to the corresponding true value. The stated accuracy objectives for organic Priority Pollutants are ± 30% for water data and ± 50% for solids data (see again Figure 1.1). These objectives may be interpreted to mean that measured values should lie between 70 and 130% of the true value for water data and between 50 and 150% of the true value for solids data. True values are known in certain laboratory QA/QC procedures involving "spiking" of a set of samples with accurately known amounts of a compound not already present. (Isotopically labeled compounds, or other compounds virtually nonexistent outside the laboratory, are used for this purpose.)

QA/OC results from the remedial investigation are compared with the above data quality objectives in the next section.

TABLE 1: QUALITY ASSURANCE OBJECTIVES

Media	Parameter	Method	Reference	Precision[a]	Accuracy[a]	Completeness[b]	Comparability	MRC[c]
Surficial Soils and Sediments	Polychlorinated Bipenyls (PCB)	GC	EPA Method 8080	±30	±50	95	mg/kg	5[d]
	Screening for Volatile Organics	GC-FID	Adaptation of EPA Methods 601 and 602 (See Appendix B)	±30	±50	95	mg/kg	
			Direct Injection EPA Method 8.80					40[d]
			Purge and Trap EPA SW-846					0.1[d]
	Sulfide (acid leachable)	Distillation/ Turbidimetric	Modification of AOAC Method for Total Sulfurous Acid in Food Samples Sulfate Measurement EPA Method 375.4	±25	±20	95	mg/kg	10
	CN	Distillation; Titrimetric	EPA Method 9010	±10	±15	95	mg/kg	2
	Cd,Cr,Pb,As,Zn	AA	EPA Methods 213.2,218.2 239.2,206.2,289.2	±25	±15	95	mg/kg	1
Waste Characterization (Test pit samples)	PCB	GC	EPA Method 8080	±30	±50	100	mg/kg	5
	Volatile Organic Priority Pollutants	GC-MS	Modified EPA Method 624 (see Appendix A)	±30	±50	100	mg/kg	0.020[d]
	Semi-Volatile Organic Priority Pollutants	GC-MS	Modified EPA Method 625 (See Appendix A)	±30	±50	100	mg/kg	0.500[d]
	Flashpoint	Closed Cup	ASTM Method D93-79	±20	±20	100	60°C	-
	EP Toxicity - Metals Only As,Ba,Cd,Cr(T),Cr(+6)Pb,Hg, Se,Ag	AA	40 CFR 261 Appendix II metals by EPA Methods 206.2,208.2,213.2,218.2,218.4 239.2,245.1,270.2272.2	±15	±15	100	mg/l	0.01 except Hg 0.001 Hg
Surface Water and Groundwater	PCB	GC	EPA Method 608	±10	±10	100	µg/l	100
	Volatile Organic Priority Pollutants	GC-MS	EPA Method 624	±30	±30	100	µg/l	1[d]
	Semi-Volatile Organic Priority Pollutants	GC-MS	EPA Method 625	±30	±10	100	µg/l	10[d]
	pH	potentiometric	See Section 9 EPA Method 150.1	±0.1 units	±0.1 units	100	pH units	2.0
	Specific Conductance	Conductance	See Section 9 EPA Method 120.1	±10	±5	100	µs/cm	15

a = percent of mean or true value; b = percent; c = MRC - Minimum Reportable Concentration;
d = Nominal MRC quaries for specific chemical, see Appendix A

FIGURE 1.1 - EXCERPT FROM E. C. JORDAN CO.'S QAPP (TABLE 1)

3.0 QA/QC DATA

Appendix A of the September 1984 remedial investigation includes a "QA/QC Portfolio," with data on recoveries of surrogate spikes. Typically, each of a set of samples is spiked with a known addition of several exotic compounds, and the concentrations are then measured. The "percent recovery" is the measured value divided by the known value, converted to a percentage. The spiked compounds, although exotic, are generally similar in physicochemical characteristics to the pollutants of actual interest in the samples, and are measured in just the same way. Thus, the surrogate recoveries are taken as a measure of the accuracy of the laboratory procedures. Similarly, the standard deviation of a set of surrogate recoveries is considered to be a measure of precision.

Tables 1.1 through 1.3 summarize surrogate-recovery precision and accuracy data from the cited appendix. The tables also show the corresponding QA objectives already discussed. Table 1.1, for purgeable halocarbons and aromatics (EPA Methods 601 and 602), shows that four different sample sets had mean percent recoveries below the corresponding objectives for one of the surrogate compounds. Two of these sample sets comprised clean water samples (field or laboratory blanks), which are expected to yield data of the best precision and accuracy. Individual samples within each set (data not shown here) of course exhibited even greater variability than the set mean values summarized in the table.

Table 1.2, for volatile organics (EPA Method 624), shows 17 violations of the corresponding accuracy objectives. Only five sets fulfilled the objectives, and some only marginally so. In addition, two sets violated precision objectives. A set of clean water samples accounted for four of the above violations.

INTRODUCTION

In connection with efforts to achieve an effective and efficient voluntary cleanup of the Acme site, a group of entities which are alleged to be potentially responsible parties formed the Acme Technical Committee. Eugene A. Hickok and Associates, Inc. was retained to review the Remedial Investigation/ Feasibility Study for the Acme site conducted by an Illinois EPA contractor.

The first section of this report concerns the QA/QC program for the Remedial Investigation. Next, groundwater monitoring data are examined. Third, an evaluation of potential remedial actions is made. Finally, the recommendations of Eugene A. Hickok and Associates, Inc. are presented.

TABLE 1.1

SUMMARY OF JORDAN (9/84) ACCURACY AND PRECISION DATA
PURGEABLE HALOCARBONS AND AROMATICS (EPA METHODS 601 AND 602)
ACME SOLVENTS DISPOSAL SITE

	PRECISION			ACCURACY		
	Standard Deviation σ for Surrogate Recoveries			Mean % Recovery $\bar{x}$ for Surrogate Recoveries		
Medium and Category*	BCM	BCP	DCB	BCM	BCP	DCB
Water	QA objective: $\sigma < 30$			QA objective: $70 < \bar{x} < 130$		
Clean Water:						
Instr. 1 (n=5)	15	18	22	88	104	50**
Instr. 2 (n=13)	12	17	20	74	91	61
Soil & Sediment	QA objective: $\sigma < 30$			QA objective: $50 < \bar{x} < 150$		
Soil and Sediment:						
Instr. 2-Spiked immediately before analysis (n=28)	16	14	13	78	85	62
Instr. 2 (n=133-139)	13	19	14	55	62	42
Instr. 1 (n=43-44)	17	29	11	63	75	33

* Instrumentation 1 = Perkin-Elmer Sigma I instrument with Tekmar LSC-2 purge and trap;
Instrumentation 2 = Perkin-Elmer Sigma 3B instrument with Hewlett-Packard Model 7675A purge and trap.

** Numbers underscored violate QA objective.

NOTE: BCM = Bromochloromethane
BCP = 2-Bromo-1-chloropropane
DCB = 1,4-Dichlorobutane

TABLE 1.2

SUMMARY OF JORDAN (9/84) ACCURACY AND PRECISION DATA
VOLATILE ORGANICS (EPA METHOD 624)
ACME SOLVENTS DISPOSAL SITE

Medium and Category	PRECISION: Standard Deviation σ for Surrogate Recoveries					ACCURACY: Mean % Recovery $\bar{x}$ for Surrogate Recoveries				
	BCM	D3B	DCB	BFB	DCE	BCM	D3B	DCB	BFB	DCE
Water.	QA objective: σ < 30					QA objective: $70 < \bar{x} < 130$				
Clean Water (n=8)	27	24	68*	19	23	60	90	26	74	59
Surface & Ground Water (n=62-63)	13	17	12	17	15	54	74	42	77	54
Solid/Semisolid Samples.	QA objective: σ < 30					QA objective: $50 < \bar{x} < 150$				
Solid/Semisolid Samples (n=41-42)	17	29	18	27	19	38	50	29	47	41
Samples prepared for EPA 601 & 602, analyzed by EPA 624 (n=25-26)	9	--	12	--	--	41	--	41	--	--
Samples scheduled for EPA 601 & 602, prep. and anal. by EPA 624 (n=6-7)	45	24	18	23	22	34	41	34	48	47

* Numbers underscored violate QA objective.

NOTE: BCM = Bromochloromethane; D3B = Benzene-d3;
DCB = 1,4-Dichlorobutane; BFB = 4-Bromofluorobenzene;
DCB = 1,2-Dichloroethane-d4

TABLE 1.3

SUMMARY OF JORDAN (9/84) ACCURACY AND PRECISION DATA
SEMIVOLATILE ORGANICS (EPA METHOD 625)
ACME SOLVENTS DISPOSAL SITE

	PRECISION: Standard Deviation σ for Surrogate Recoveries					ACCURACY: Mean % Recovery $\bar{x}$ for Surrogate Recoveries				
Medium and Category	D5P	PFP	DFB	DCP	D8N	D5P	PFP	DFB	DCP	D8N
Water	QA objective: σ < 30					QA objective: $70 < \bar{x} < 130$				
Surface & Ground Water (n=46-55)	10	14	25	32*	19	25	27	56	77	54
Solid/Semisolid Samples	QA objective: σ < 30					QA objective: $50 < \bar{x} < 150$				
Solid/Semisolid Samples (n=37-46)	32	37	38	39	45	45	53	37	67	45

* Numbers underscored violate QA objective.

NOTE: D5P = Phenol-d5; PFP = Pentafluorophenol;
DFB = Decafluorobiphenyl; DCP = 2,4-Dichlorophenol-d3;
D8N = Naphtalene-d8

Table 1.3, for semivolatile organics (EPA Method 625), shows 13 precision and accuracy objective violations out of 20 possibilities.

This brief summary of QA/QC data from the remedial investigation indicates that laboratory measurements of chemical parameters fell significantly short of the stated data quality objectives.

4.0 COMPARISON OF DIFFERENT GROUNDWATER DATA SETS

Prior to the remedial investigation (RI), U.S. EPA contracted a "FIT" (Field Investigation Team) investigation to determine the extent and sources of groundwater contamination in the area of the Acme site and nearby Pagel's Pit (Ecology and Environment, Inc., March 1983). Seventeen monitoring wells constructed for the FIT project, as well as five domestic wells, have been monitored both in the FIT investigation (in October-November 1982) and in the remedial investigation (in May 1984). The FIT study utilized U.S. EPA contract laboratories; no QA/QC data are reported. Tables 1.4 through 1.6 make various comparisons between the two sets of data.

The FIT study found a large number of organic Priority Pollutants in one or more monitoring wells that were not detected in the RI in any of the wells. Table 1.4 lists the specific compounds together with data showing all of the FIT study's reported detections. Seven organic acid Priority Pollutants, 20 base-neutrals, and eight volatiles were detected in various monitoring wells in the FIT study but not in any of the wells in the RI. Most of the detections in Table 1.4 are for wells B-2 and B-11, located at the northern boundary of the Acme site and 200 feet east of the Pagel's Pit landfill boundary, respectively. The RI found <u>no</u> semivolatiles (including both acid and base-neutral compounds) in either well, compared with 19 or more such compounds found in these two wells in the FIT study.

Table 1.5 compares data for those compounds that the RI and FIT study both found in at least one monitoring well. Differences by factors of two or three are common throughout the table. Order-of-magnitude differences occur for well B-4, at the southern boundary of the Acme site, for the compounds trans-1,2-dichloroethylene and tetrachloroethylene. But what is more striking is that the concentrations found in the RI are on the average significantly less than those found in the FIT study.

TABLE 1.4

ORGANIC PRIORITY POLLUTANTS FOUND IN "FIT" INVESTIGATION
BUT NOT IN REMEDIAL INVESTIGATION - WELLS B-1 THROUGH B-16

Compound	Concentration (ug/l) Found in Wells						
	B-11	B-1	B-2	B-15	B-4	B-12	B-13
ACIDS							
p-Chloro-m-cresol	100	--	--	--	--	--	--
2-Chlorophenol	94	--	--	--	--	--	--
2,4-Dichlorophenol	94	--	--	--	--	--	--
2,4-Dimethylphenol*	58	--	--	--	--	--	--
2,4-Dinitrophenol	340	--	--	--	--	--	--
Phenol*	36	--	--	--	--	--	--
Pentachlorophenol	82	<40	--	--	--	--	--
BASE-NEUTRALS							
Acenaphthene	120	--	98	--	--	--	--
1,2,4-Trichlorobenzene	110	--	110	--	--	--	--
Bis(2-chloroethyl)ether	24	--	--	<10	--	--	--
1,4-Dichlorobenzene	116	--	90	--	--	--	--
2,4-Dinitrotoluene	130	--	110	--	--	--	--
Bis(2-chloroethoxy)methane	110	--	92	--	--	--	--
Hexachlorobutadiene	110	--	100	--	--	--	--
Naphthalene*	130	--	110	--	--	--	--
n-Nitrosodi-n-porpylamine	500	--	480	--	--	--	--
Diethyl phthalate*	62	--	54	--	--	<20	--
Di-n-octyl phthalate	140	--	96	<10	--	--	--
Dimethyl phthalate*	20	--	<20	--	--	--	--
Benzo(a)pyrene	90	--	96	--	--	--	--
Benzo(b)fluorathene	160	--	120	--	--	--	--
Chrysene	120	--	100	--	--	--	--
Acenaphthylene	170	--	130	--	--	--	--
Fluorene	120	--	94	--	--	--	--
Phenanthrene	120	--	100	--	--	--	--
Dibenzo(a,h)anthracene	86	--	110	--	--	--	--
Pyrene	150	--	88	--	--	--	--
VOLATILES							
Carbon tetrachloride	--	--	<5	--	--	--	--
1,2-Dichloroethane	--	<5	--	--	10.	6	<5
1,1,2-Trichloroethane*	--	--	--	--	6.7	--	--
Chlorobenzene	--	--	--	<5	--	--	--
Chloroethane	--	--	--	<10	<5	--	--
Chloroform	--	<5	--	--	<5	--	--
Methylene chloride*	--	<5	--	--	--	7	<5
Fluorotrichloromethane	--	--	--	--	<5	--	--

Data Sources: E. C. Jordan (Sept. 1984) and Ecology and Environment (March 1983).

Note: Dashes are shown here wherever Ecology and Environment's March 1983 report gives blanks; apparently, such reported values as "<5" indicate detection but not quantitation, while blanks (dashes here) indicate non-detection. The wells shown include all reported detections.

* Starred compounds are reported in Jordan (Sept. 1984), Appendix F, but in all cases as "not detected"; remaining compounds are not listed at all in Jordan (Sept. 1984), Appendix F.

TABLE 1.5

ORGANIC PRIORITY POLLUTANTS FOUND IN BOTH "FIT" INVESTIGATION AND REMEDIAL INVESTIGATION - WELLS B-1 THROUGH B-16*

Compound	B-1		B-2		B-3		B-4		B-5		B-6-S		B-6-D		B-7	
	FIT	RI	FIT	RI	FIT	RI	FIT**	RI	FIT	RI	FIT	RI	FIT	RI	FIT	RI
BASE-NEUTRALS																
Bis(2-ethylhexyl)phthalate	--	48	<20	--	--	--	--	--	--	--	--	--	24	--	--	--
Di-n-butyl phthalate	--	--	80	--	--	--	--	--	--	--	--	--	--	--	--	--
Total Base-Neutrals****:	--	48	80	--	--	--	--	--	--	--	--	--	24	--	--	--
VOLATILES																
Benzene	--	--	--	--	--	--	<5	--	--	--	--	--	11	--	--	--
1,1,1-Trichloroethane	64	45	28	36	--	--	580	240	<5	13	--	--	--	--	--	--
1,1-Dichloroethane	7.2	2.4	<5	2.7	--	--	175	150	<5	14	--	--	--	--	--	--
1,1-Dichloroethylene	5	--	--	--	--	--	18	13	--	--	--	--	--	--	--	--
Trans-1,2-dichloroethylene	57	18	12	5.1	--	--	380	>2,400	28	74	--	--	--	5.1	--	3.0
1,2-Dichloropropane	--	--	<5	--	--	--	7.6	--	--	--	--	--	--	--	--	--
Ethyl benzene	--	--	--	--	--	--	--	31	--	--	--	--	--	--	--	--
Tetrachloroethylene	54	48	22	25	--	--	5,800	470	6.1	--	--	--	--	--	--	--
Toluene	--	--	<5	--	<5	--	<5	40	--	--	--	--	--	--	--	--
Trichloroethylene	33	18	57	40	--	--	825	170	<5	4.3	--	--	--	--	--	--
Vinyl chloride	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Xylene***	--	--	--	--	--	--	<5	280	--	--	--	--	--	--	--	--
Total Volatiles****:	220.2	131.4	119	108.8	<5	--	7,785.6	3,794	34.1	105.3	--	--	11	5.1	--	3.0

Data Sources: E. C. Jordan (Sept. 1984) and Ecology and Environment (March 1983).
Note: Dashes indicate non-detection (originally blanks in Ecology and Environment report); also column totals ignore "less-than" values unless only such values contribute to total.

* All detected values reported by Jordan (Sept. 1984) appear in this table; additional detections by Ecology and Environment appear in accompanying table.

** Averages of two duplicate analyses for well B-4; all duplicate results within 20% of one another, except for tetrachloroethylene (500 and 11,100 ug/l).

*** Ecology and Environment (March 1983) reports o-xylene; Jordan (Sept. 1984) reports "xylenes."

**** For Ecology and Environment data, these "totals" exclude compounds not also found in at least one well by E. C. Jordan (see accompanying table for the additional data).

TABLE 1.5 (continued)

ORGANIC PRIORITY POLLUTANTS FOUND IN BOTH "FIT" INVESTIGATION AND REMEDIAL INVESTIGATION - WELLS B-1 THROUGH B-16*

Compound	B-8		B-9		B-10		B-11		B-12		B-13		B-14		B-15		B-16	
	FIT	RI	FIT	RI	FIT	RI	FIT	RI	FIT	RI	FIT	RI	FIT	RI	FIT	RI	FIT	RI
BASE-NEUTRALS																		
Bis(2-ethylhexyl)phthalate	<20	10	--	42	22	--	--	--	--	--	--	76	--	--	--	26	--	--
Di-n-butyl phthalate	--	--	--	--	--	--	110	--	--	--	--	--	--	--	--	--	--	--
Total Base-Neutrals****:	<20	10	--	42	22	--	110	--	--	--	--	76	--	--	--	26	--	--
VOLATILES																		
Benzene	--	--	--	--	7	--	<5	--	19	--	8.9	--	--	--	15	7.9	5	--
1,1,1-Trichloroethane	--	--	--	--	<5	--	--	--	--	--	<5	2.6	--	--	--	--	--	--
1,1-Dichloroethane	--	--	--	--	<5	--	--	--	83	42	32	24	--	--	--	6.4	--	--
1,1-Dichloroethylene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	20	--	--	--
Trans-1,2-dichloroethylene	--	--	--	--	65	18	<5	4.0	400	250	--	130	--	--	18	--	29	6.8
1,2-Dichloropropane	--	--	--	--	<10	--	--	--	16	6.0	7	--	--	--	12	6.6	--	--
Ethyl benzene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	27	11	--	--
Tetrachloroethylene	--	--	--	--	10	--	<5	--	57	23	42	25	--	--	<5	--	--	--
Toluene	<5	--	--	--	--	--	<5	--	--	--	--	--	--	--	--	--	--	--
Trichloroethylene	--	--	--	--	9	--	<5	--	140	30	94	42	--	--	<5	--	--	--
Vinyl chloride	--	--	--	--	11	--	--	--	22	160	19	--	--	--	11	--	--	--
Xylene***	--	--	--	--	--	--	--	--	--	--	--	--	--	--	8	--	--	--
Total Volatiles****:	<5	--	--	--	102	18	<25	4.0	737	511	202.9	223.6	--	--	111	31.9	34	6.8

Data Sources: E. C. Jordan (Sept. 1984) and Ecology and Environment (March 1983).
Note: Dashes indicate non-detection (originally blanks in Ecology and Environment report); also column totals ignore "less-than" values unless only such values contribute to total.

* All detected values reported by Jordan (Sept. 1984) appear in this table; additional detections by Ecology and Environment appear in accompanying table.

** Averages of two duplicate analyses for well B-4; all duplicate results within 20% of one another, except for tetrachloroethylene (500 and 11,100 ug/l).

*** Ecology and Environment (March 1983) reports o-xylene; Jordan (Sept. 1984) reports "xylenes."

**** For Ecology and Environment data, these "totals" exclude compounds not also found in at least one well by E. C. Jordan (see accompanying table for the additional data).

TABLE 1.6

ORGANIC PRIORITY POLLUTANTS FOUND IN EITHER "FIT" INVESTIGATION OR REMEDIAL INVESTIGATION - RESIDENTIAL WELLS F, G, H, J AND L

Compound	F		G		H		J		L	
	FIT	RI	FIT	RI	FIT	RI	FIT	RI	FIT	RI
BASE-NEUTRALS										
Di-n-butyl phthalate	--	--	<20	--	--	--	--	--	--	--
Total Base-Neutrals:	--	--	<20	--	--	--	--	--	--	--
VOLATILES										
Benzene	--	--	7.4	--	--	--	--	--	--	--
1,1,1-Trichloroethane	12	6.4	--	--	13	--	<5	--	--	--
1,1-Dichloroethane	12	5.8	22	5.9	16	--	--	--	--	--
Trans-1,2-dichloroethylene	710	45	73	30	210	--	<5	--	--	--
1,2-Dichloropropane	<5	1.7	--	--	--	--	--	--	--	--
Methylene chloride	--	--	55	--	--	--	--	--	--	--
Fluorotrichloromethane	--	--	<5	--	--	--	--	--	--	--
Tetrachloroethylene	23	6.7	51	10	11	--	<5	--	--	--
Trichloroethylene	35	10	57	8.0	13	--	--	--	--	--
Vinyl chloride	--	--	21	--	--	--	--	--	--	--
Total Volatiles:	792	75.6	286.4	53.9	263	--	<15	--	--	--

Data Sources: E. C. Jordan (Sept. 1984) (sampling May 1984) and Ecology and Environment (March 1983) (sampling October-November 1982).

Note: Dashes indicate non-detection (originally blanks in Ecology and Environment report); column totals ignore "less-than" values unless only such values contribute to total. Capital letter well designations follow those in the Jordan (Sept. 1984) report.

A linear regression on the RI (dependent variable) versus FIT (independent variable) total volatiles values yielded the following results*:

	Regression Coefficient, or Slope	Residual, or Intercept (ug/l)	Correlation Coefficient, r
All wells in Table 5 (n=17)	+ 0.486	22.6	+ .998
Wells excluding B-4 (n=16)	+ 0.698	2.5	+ .963

The two data sets correlate very highly; however, the significant deviation from unity in the regression coefficient suggests that the RI measurements are on the average some 30 to 50% lower than the FIT data.

The RI's generally low surrogate recovery percentages, discussed in the previous section, are consistent with the regression findings and suggest systematic errors in the RI data.

Table 1.6 compares data for the five domestic wells sampled in both investigations. Again, a systematic bias is evident as for the monitoring wells, and several compounds were detected in wells G, H, and J by the FIT study which were not detected there in the RI. There is a need for further, accurate data for these wells, to evaluate whether they are in fact getting cleaner, or merely exhibiting systematic measurement errors.

*Note that in the regressions, totals of "--" were taken as zero, and totals such as "<25" were taken as one-half the numerical value (12.5 in this example).

5.0 CORRELATIONS AMONG GROUNDWATER QUALITY DATA FROM REMEDIAL INVESTIGATION

All of the groundwater quality data from the remedial investigation are summarized in Table 1.7. The data are condensed into three parameters: the particular compound trans-1,2-dichloroethylene (here abbreviated DCE); total volatile organics, which include DCE; and total semivolatile organics, which represents the specific compound bis(2-ethylhexyl)phthalate in all cases here but one. Table 1.7 includes data for 46 wells.

5.1 Well Construction

Well construction techniques are a QA/QC concern, and one way of investigating possible impacts on subsequent groundwater quality data is to inspect the data for systematic differences. E. C. Jordan (RI) and Ecology and Environment (FIT) used different well construction techniques. Ecology and Environment's wells are generally shallower than Jordan's wells but of comparable depth to Jordan's piezometers. The mean concentrations and the detection frequencies shown in Table 1.7 for the former's wells and the latter's piezometers are quite comparable when well B-4 is excluded. (Well B-4 should be excluded from such a comparison because its concentrations are one to three orders of magnitude greater than any other well sampled.) This suggests that differences in construction have not caused differences in chemical quality between the two sets of wells and piezometers.

5.2 Semivolatiles

Semivolatiles do not correlate with either DCE or total volatiles in Table 1.7. (Absolute value of the correlation coefficient r is less than .04 in both cases.) This suggests that the semivolatiles have a different source from the other organic pollutants. As observed also by Jordan (September 1984), laboratory contamination is a possible and plausible source for phthalates, the only type of semivolatiles involved here.

TABLE 1.7

SUMMARY OF GROUNDWATER QUALITY DATA
FROM ACME SITE REMEDIAL INVESTIGATION

Well	Concentration (micrograms per liter) Trans-1,2-dichloroethylene	Total Volatiles	Total Semivolatiles*
E. C. Jordan Wells:			
MW-101	--	--	--
MW-102	7.8	7.8	9.3
MW-103	--	3.7	10
MW-104	38	52	--
MW-105	--	--	52**
MW-106	25	42	220
MW-107	5.6	5.6	--
Mean (n=7)	11	16	42
Detection Frequency (%)	57	71	57
E. C. Jordan Piezometers:			
P-1	9.1	19	--
P-3	28	52	58
P-4	48	90	--
P-5	56	100	--
P-6	--	--	--
P-7	--	--	--
Mean (n=6)	24	44	9.7
Detection Frequency (%)	67	67	17
Ecology & Environment Wells:			
B-1	18	130	48
B-2	5.1	110	--
B-3	--	--	--
B-4	>2,400	>3,800	--
B-5	74	110	--
B-6S	--	--	--
B-6D	5.1	5.1	--
B-7	3.0	3.0	--
B-8	--	--	10
B-9	--	--	42
B-10	18	18	--
B-11	4.0	4.0	--
B-12	250	510	--
B-13	130	220	76
B-14	--	--	--
B-15	--	32	26
B-16	6.8	6.8	--
Mean - All E + E Wells (n=17)	170	290	12
Mean - Excluding B-4 (n=16)	32	72	13
Detection Frequency (%)	65	71	29

TABLE 1.7 (continued)

SUMMARY OF GROUNDWATER QUALITY DATA
FROM ACME SITE REMEDIAL INVESTIGATION

Well	Concentration (micrograms per liter) Trans-1,2-dichloroethylene	Total Volatiles	Total Semivolatiles*
Domestic Wells:			
A	--	--	--
B	--	--	--
C	--	--	--
D	--	--	--
E	57	69	--
F	45	76	--
G	30	54	--
H	--	--	--
J	--	--	--
K	--	--	--
L	--	--	--
M	--	--	--
N	--	--	--
O	--	--	--
Mean (n=14)	9.4	14	--
Detection Frequency (%)	21	21	0
Other Wells:			
G-101	38	77	--
G-102	--	--	--
Mean - All Wells (n=46)	72	120	12
Mean - Excluding B-4 (n=45)	20	39	12
Detection Frequency (%)	50	54	22

DATA SOURCE: E. C. Jordan (September 1984).

NOTE: Non-detections ("--") taken as zero in computations of mean values; the value ">2,400" was taken as 2,400, and similarly for >3,800.

* Bis(2-ethylhexyl)phthalate was the only semivolatile compound found by Jordan, except as noted below.

** Well MW-105 had di-n-butyl phthalate at 22 ug/l in addition to bis(2-ethylhexyl)phthalate at 30 ug/l.

5.3 Volatiles

A remarkable correlation exists between DCE and total volatiles as measured in the remedial investigation. The correlation coefficient is $r = +.999$ (n=46).* The derived linear regression model is: total volatiles = (1.58) DCE + 7.95 (ug/l); and this model explains 99.8% of the overall variability in the total volatiles data (i.e., $r^2 = .998$). Note further that out of 46 wells: (1) 21 wells had non-detections for both DCE and total volatiles; (2) seven wells had measurable total volatiles = DCE; and (3) only two wells had measurable total volatiles but with DCE not detected.

The above observations and correlation results based on the remedial investigation's groundwater quality data imply that, in the general vicinity of the Acme site, groundwater contamination with volatile organics is virtually *co-definitional with groundwater contamination with DCE*.

But this leads to a serious contradiction, for the test pit data from the Acme site reveal DCE only sparingly in the waste materials believed to be a major source of the groundwater contamination. Out of 54 test pit samples (excluding duplicates), only four showed measurable DCE. The concentrations in these four samples were as follows:

Test Pit Samples		DCE Concentration (milligrams per kilogram)
1	S-4	2.5
4	S-3	3.2
4	S-5	20
5	S-3	0.069

If the data are to be trusted, they seem to imply that the Acme site is not a substantial source of groundwater contamination in the vicinity. If this proposition is not correct, then the implication is that chemical measurements in the remedial investigation reflect serious shortcomings in regard to the conduct of QA/QC procedures.

*As in previous analyses, values of "--" were taken as zero, and the numerical values were assumed for ">2,400" and ">3,800."

6.0 UPGRADIENT WELL

Well MW-102 was constructed as part of the remedial investigation "to establish an upgradient monitoring location" (Jordan, September 1984; page 14). The well is approximately 750 feet east of the Acme site boundary, and its depth is 54 feet. Sampling revealed measurable DCE (7.8 ug/l) and bis(2-ethylhexyl) phthalate (9.3 ug/l). These findings could be a further indication of QA/QC shortcomings, or could reflect upgradient contaminant source(s).

7.0 SUMMARY OF IDENTIFIED SHORTCOMINGS

This review of QA/QC procedures and data from the remedial investigation identifies the following shortcomings:

1. The RI's laboratory QA/QC data exhibit numerous violations of quality assurance objectives for precision and accuracy.

2. A systematic bias between a previous groundwater quality data set and the remedial investigation's data set strongly implies systematic measurement errors in at least one of the two laboratories involved.

3. The lack of correlation between semivolatiles and other organics in the remedial investigation's groundwater data suggests that the semivolatiles are from a different source; laboratory contamination is a possible and plausible alternative source.

4. The near-perfect correlation between groundwater concentrations of trans-1,2-dichloroethylene (DCE) and total volatiles, taken together with the very sparse detection of DCE in test pit samples from waste deposits on the Acme site, indicate serious accuracy problems with the remedial investigation's chemical data.

5. The upgradient monitoring well had measurable DCE and bis(2-ethylhexyl) phthalate, which further indicates QA/QC shortcomings and/or reflects upgradient contaminant source(s).

6. Additional, accurate groundwater quality monitoring is necessary for the evaluation of various conclusions drawn in the remedial investigation.

8.0 REFERENCES

Ecology and Environment, Inc. (March 1983), "Extent of Sources of Groundwater Contamination - Acme Solvents - Pagel's Pit Area Near Morristown, Illinois." Prepared for U.S. EPA.

Jordan, E. C., Co. (January 1984), "Quality Assurance Project Plan (QAPP) for Remedial Investigation/Feasibility Study for the ACME Solvent Superfund Site." Portland, Maine.

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U.S. Environmental Protection Agency (1980), "Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans." OAMS-005/80. Washington.

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PART TWO

REVIEW OF GROUNDWATER MONITORING DATA FOR THE REMEDIAL INVESTIGATION

REVIEW OF GROUNDWATER MONITORING DATA FOR

REMEDIAL INVESTIGATION OF ACME SOLVENTS SUPERFUND SITE

1.0 INTRODUCTION

This memorandum reviews the following aspects of the Acme Solvents Superfund Site remedial investigation (E. C. Jordan Co., Sept. 1984).

- Well locations and installation
- Permeability determination
- Groundwater flow
- Other sites' influence on Acme site
- Effects on adjacent intermittent stream

A key finding is the implication of upgradient source(s) of groundwater contamination, probably including Rockford Blacktop Company. A critical concern is the construction of several monitioring wells with very long sand-pack intervals; these wells are probably contributing to the vertical spreading of groundwater contaminants in the Acme site vicinity.

The conclusions (section 7.0) provide a concise version of the memorandum.

2.0 WELL LOCATIONS AND INSTALLATION

The wells for which the remedial investigation reports water level and/or water quality data are shown in Figure 2.1, with designations as used in the RI report (Ibid.). Fifty wells and piezometers are included. Of these, 30 have both water level and quality data, 16 have water quality data only, and four have water level data only.

Figure 2.2 displays the wells by investigator or owner. E. C. Jordan Co. installed 15 wells and piezometers as part of the RI. Ecology and Environment, Inc., installed 17 wells under a FIT contract. In addition there are 14 domestic wells and four "others" (described in the RI as wells installed by the Pagel's Pit landfill owner or by a government agency).

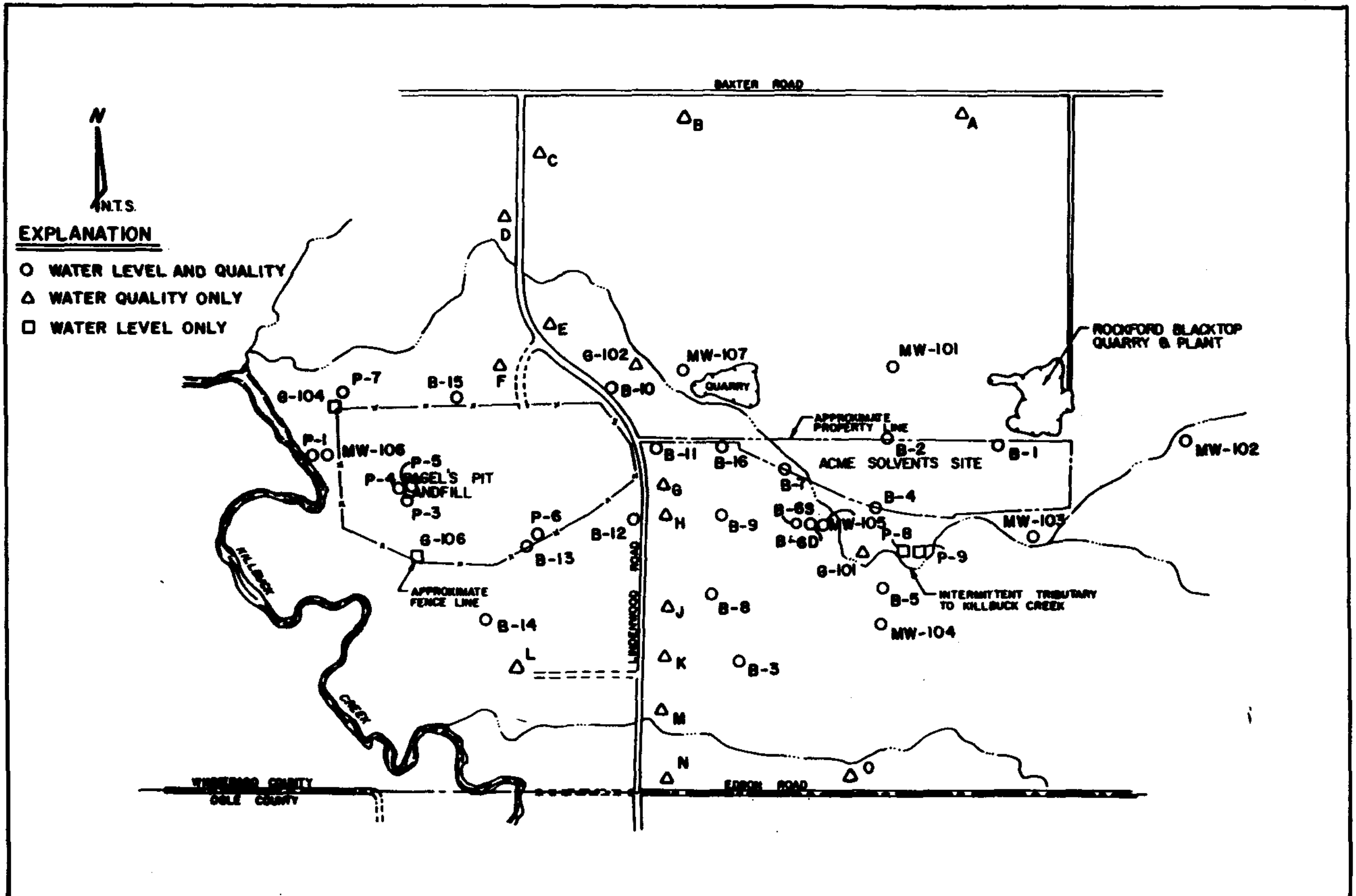
Table 2.1 summarizes location and installation data for those wells having some construction documentation available. The table excludes 13 of the 14 domestic wells because of lack of construction data, but otherwise includes all the wells in Figures 2.1 and 2.2.

2.1 Well Installation

2.1.1 Long Sand Pack Intervals

All of the monitoring wells installed in the RI and FIT studies have 5- to 10-foot well screens, however many of the wells have much longer sand-pack intervals. Well MW-107 (RI) has a 78-foot sand pack, while well B-6D (FIT) has a 60-foot sand pack. Wells MW-103 and MW-104 (both RI) have sand-pack intervals greater than 30 feet. Nine other wells have sand packs over 20 feet long.

There are two serious problems with wells having long intervals of either screen or sand pack. First, monitoring data are less definite, more difficult to interpret, and all in all less useful than data form wells with short screens



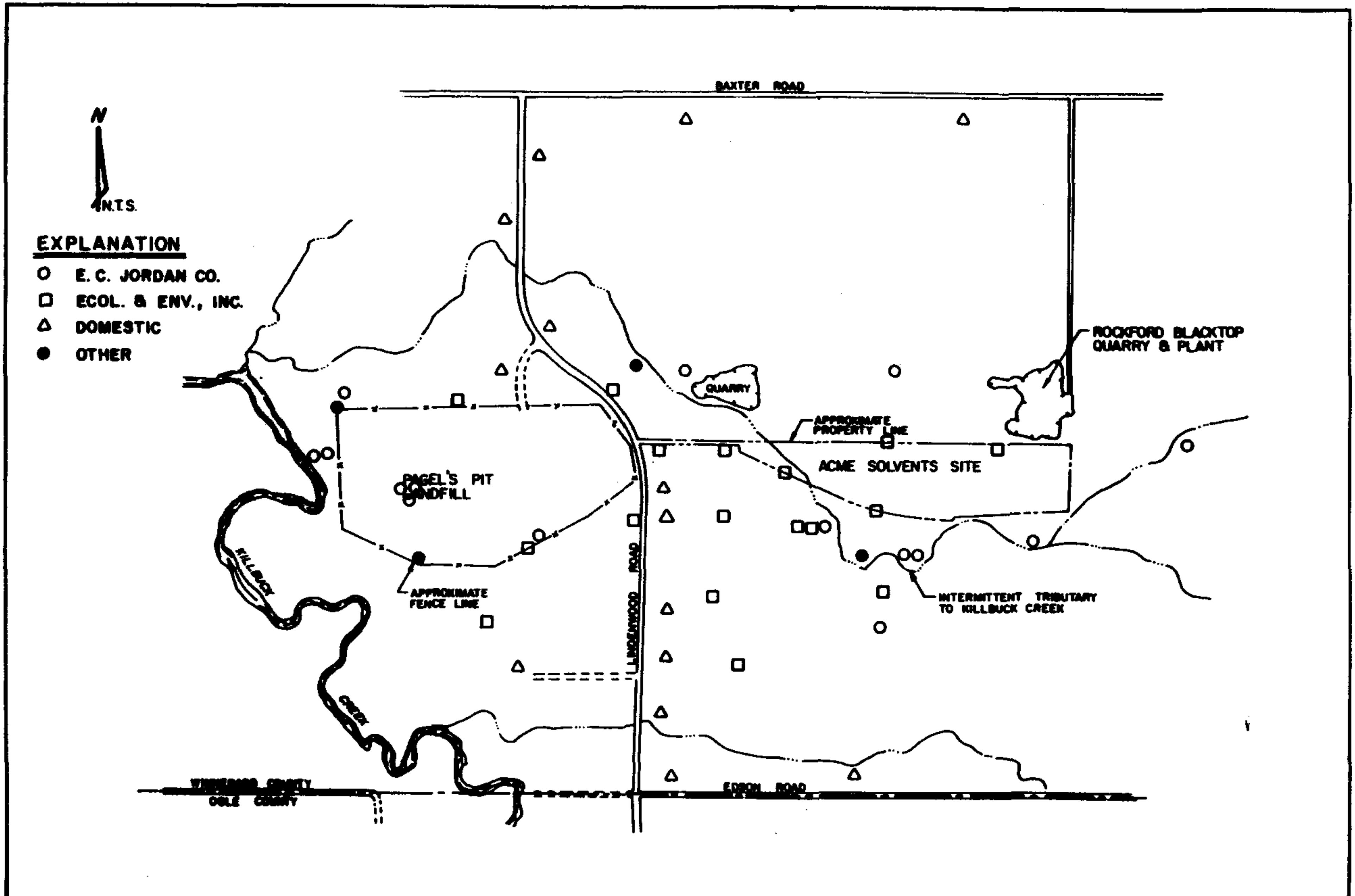
ACME SOLVENTS SUPERFUND SITE

LOCATION OF WELLS WITH WATER LEVEL AND/OR WATER QUALITY DATA IN REMEDIAL INVESTIGATION

E.A. HICKOK & ASSOCIATES
HYDROLOGISTS-ENGINEERS
MINNEAPOLIS-MINNESOTA

MAR. 1985

2.1



ACME SOLVENTS SUPERFUND SITE	E.A. HICKOK & ASSOCIATES HYDROLOGISTS-ENGINEERS MINNEAPOLIS-MINNESOTA	MAR. 1985
WELL LOCATIONS BY INVESTIGATOR/OWNER		2.2

TABLE 2.1

WELL LOCATION AND INSTALLATION DATA
ACME SOLVENTS DISPOSAL SITE

Well Designation	Investigator or Owner	Well Driller	Construction Documentation	Location	Aquifer Material Where Screened	Elevation (ft above msl) Screen	Elevation (ft above msl) Sand Pack	Elevation (ft above msl) Approx. W.L.	Approx. Depth below W.L. (ft) Screen	Approx. Depth below W.L. (ft) Sand Pack
MW-101	Jordan	Mathes & Assoc.	Jordan (9/84)	N of Acme 500 ft	Bedrock	697-707	697-721	730	23-33	9-33
MW-102	Jordan	Mathes & Assoc.	Jordan (9/84)	E of Acme 750 ft	Bedrock	705-710	705-729	732	22-27	3-27
MW-103	Jordan	Mathes & Assoc.	Jordan (9/84)	SE of Acme 200 ft	Bedrock	689-694	689-725	731	37-42	6-42
MW-104	Jordan	Mathes & Assoc.	Jordan (9/84)	S of Acme 800 ft	Bedrock	619-629	619-652	727	98-108	75-108
MW-105	Jordan	Mathes & Assoc.	Jordan (9/84)	SW of Acme 250 ft	Bedrock	675-685	675-687	730	45-55	43-55
MW-106	Jordan	Mathes & Assoc.	Jordan (9/84)	Between Pag. Pit & Killbuck Creek	Gravel	665-675	665-678	707	32-42	29-42
MW-107	Jordan	Mathes & Assoc.	Jordan (9/84)	NW of Acme 600 ft	Bedrock	598-608	598-676	720	112-122	44-122
P-1	Jordan	Mathes & Assoc.	Jordan (9/84)	Between Pag. Pit & Killbuck Creek	Gravel	690-695	690-697	707	12-17	10-17
P-3	Jordan	Mathes & Assoc.	Jordan (9/84)	At Pag. Pit, W-central	Gravel	703-708	703-710	706	(2)-3	(4)-3
P-4	Jordan	Mathes & Assoc.	Jordan (9/84)	At Pag. Pit, W-central	Gravel	682-687	682-688	707	20-25	19-25
P-5	Jordan	Mathes & Assoc.	Jordan (9/84)	At Pag. Pit, W-central	Bedrock	661-666	661-668	706	40-45	38-45
P-6	Jordan	Mathes & Assoc.	Jordan (9/84)	At Pag. Pit, SE edge	Bedrock	687-692	687-693	714	22-27	21-27
P-7	Jordan	Mathes & Assoc.	Jordan (9/84)	At Pag. Pit, NW corner	Gravel	697-702	697-705	707	5-10	2-10
P-8	Jordan	Mathes & Assoc.	Jordan (9/84)	S of Acme 250 ft	Bedrock	710-715	710-716	728	13-18	12-18
P-9	Jordan	Mathes & Assoc.	Jordan (9/84)	S of Acme 250 ft	Bedrock	695-700	695-701	729	29-34	28-34
B-1	Ecol. & Env.	Warzyn Eng.	E & E (3/83)	At Acme, NE edge	Bedrock	725-731	719-735	731	0-6	(4)-12
B-2	Ecol. & Env.	Warzyn Eng.	E & E (3/83)	At Acme, N edge	Bedrock	718-723	717-737	730	7-12	(7)-13
B-3	Ecol. & Env.	Warzyn Eng.	E & E (3/83)	SW of Acme 1,300 ft	Clay	708-713	702-719	739	26-31	20-37
B-4	Ecol. & Env.	Warzyn Eng.	E & E (3/83)	At Acme, S edge	Bedrock	720-725	718-739	732	7-12	(7)-14

TABLE 2.1 (continued)

Well Designation	Investigator or Owner	Well Driller	Construction Documentation	Location	Aquifer Material Where Screened	Elevation (ft above msl) Screen	Elevation (ft above msl) Sand Pack	Elevation (ft above msl) Approx. W.L.	Approx. Depth below W.L. (ft) Screen	Approx. Depth below W.L. (ft) Sand Pack
B-5	Ecol. & Env.	Warzyn Eng.	E & E (3/83)	S of Acme 600 ft	Clay	714-719	712-726	724	5-10	(2)-12
B-6S	Ecol. & Env.	Warzyn Eng.	E & E (3/83)	SW of Acme 250 ft	Bedrock	703-709	700-717	730	21-27	13-30
B-6D	Ecol. & Env.	Warzyn Eng.	E & E (3/83)	SW of Acme 250 ft	Bedrock	652-657	652-712	725	68-73	13-73
B-7	Ecol. & Env.	Warzyn Eng.	E & E (3/83)	At Acme, SW edge	Bedrock	718-723	715-737	732*	9-14	(5)-17
B-8	Ecol. & Env.	Warzyn Eng.	E & E (3/83)	SW of Acme 1,000 ft	Clay	713-718	712-722	721	3-8	(1)-9
B-9	Ecol. & Env.	Warzyn Eng.	E & E (3/83)	SW of Acme 500 ft	Bedrock	714-719	713-741	722	3-8	(19)-9
B-10	Ecol. & Env.	Warzyn Eng.	E & E (3/83)	NE of Pag. Pit 200 ft	Bedrock	702-707	702-725	713	6-11	(12)-11
B-11	Ecol. & Env.	Warzyn Eng.	E & E (3/83)	E of Pag. Pit 200 ft	Bedrock	710-716	710-729	720	4-10	(9)-10
B-12	Ecol. & Env.	Warzyn Eng.	E & E (3/83)	SE of Pag. Pit 200 ft	Bedrock	709-715	709-730	721	6-12	(9)-12
B-13	Ecol. & Env.	Warzyn Eng.	E & E (3/83)	At Pag. Pit, SE edge	Bedrock	704-709	704-716	714	5-10	(2)-10
B-14	Ecol. & Env.	Warzyn Eng.	E & E (3/83)	S of Pag. Pit 400 ft	Clay	700-705	699-708	712	7-12	4-13
B-15	Ecol. & Env.	Warzyn Eng.	E & E (3/83)	N of Pag. Pit 50 ft	Gravel	703-708	702-726	708	0-5	(18)-6
B-16	Ecol. & Env.	Warzyn Eng.	E & E (3/83)	W of Acme 150 ft	Bedrock	715-721	715-738	725	4-10	(13)-10
G-101	IEPA	Unknown	IEPA logs (9/81)	S of Acme 300 ft	Gravel, sand and bedrock	NA	722-735	727	NA	(8)-5
G-102	IEPA	Unknown	IEPA logs (9/81)	NE of Pag. Pit 400 ft	Gravel, sand and bedrock	716-722	NA	714	2-8	NA
G-104	IEPA	Unknown	Jordan (9/84)	At Pag. Pit, NW corner	Clay and gravel	NA	NA	706	NA	NA
G-106	IEPA	Unknown	Jordan (9/84)	At Pag. Pit, S edge	NA	NA	NA	710	NA	NA
J	McLellan	L. Livingston	IGS well record (1974)	SW of Acme 1,200 ft	Bedrock	NA	NA	NA	36-101**	NA

* Water level unusually variable.
** Domestic well apparently open hole in bedrock.

and sand packs. These comments apply to both water level data and water quality data. When a water level is measured, what stratum of the aquifer does it represent? This question is especially important where significant vertical head gradients exist, as is the case in the vicinity of the Acme site (see section 4.2). It is usual to assign water level measurements to the mid-depth of the sand pack interval, an approximation which is in most cases a practical necessity. But with long sand pack intervals this approximation can easily lead to significant errors. Similarly, what stratum does a water quality sample taken from a long-sand pack well represent? This points to the second and more serious problems with such wells.

Especially where there are vertical groundwater flow gradients, a water quality sample taken from a long-sand pack well can originate largely from strata far removed from the screen location. For example, if there are downward gradients, and the screen is near the bottom of the sand pack, a water sample drawn "at the screen" may include substantial groundwater from higher levels of the aquifer; this water will tend to flow downward through the sand pack both because of the vertical head gradient in the aquifer and because of the sample withdrawal. So it is difficult to interpret water quality data from such wells.

But what is more important, groundwter will tend to flow from one aquifer stratum to another through a long sand pack whenever there is a vertical gradient, not just when a sample is drawn. And as noted before, significant vertical head gradients exist in the Acme site vicinity. Therefore, <u>the monitoring wells with long sand packs are probably contributing to the vertical spread of contaminants in the vicinity</u>.

2.1.2 Other Aspects of well Installation

Water was used in the drilling of all the RI wells and piezometers and of one FIT well (B-6D). Water used for the RI well drilling was obtained from City of Rockford fire hydrants (John Mathes and Assoc., personal communication). Water used in drilling well B-6D was reported as "clean potable water" (Ecology and Environment, Inc., March 193). However, no water quality analyses were reported for samples of either water. Thus the possibility cannot be ruled out that some contaminants were present in water used in drilling the above wells.

Well drilling in the FIT study included decontamination procedures. The drill rig and accessories were intiially steam-cleaned. Between borings the augers and cutting bit were water-washed, then rinsed with acetone and allowed to air-dry. However, no decontamination procedures are reported for the RI. If in fact no such procedures were followed, then cross-contamination may have occurred among the RI wells.

The RI well drilling used a bentonite-montmorillonite drilling mud supplied by NL Baroid and called Quik-Gel (John Mathes and Assoc., personal communication). The "NL Baroid Environmental, Safety and Transportation Data Sheet" lists the following "typical analysis of toxic elements" for Quick-Gel:

Arsenic	1.5 ppm
Cadmium	0.25 ppm
Chromium	1.0 ppm
Cobalt	1.8 ppm
Lead	21.0 ppm
Mercury	0.04 ppm
Nickel	<1.0 ppm

In view of the above, groundwater monitoring data for certain metals would have to be viewed with caution. The lead concentrations in Quik-Gel exceeds the mean concentration in soils at the Acme site (7.8 ppm; Jordan, Sept. 1984, Table 7).

2.2 Location of Wells

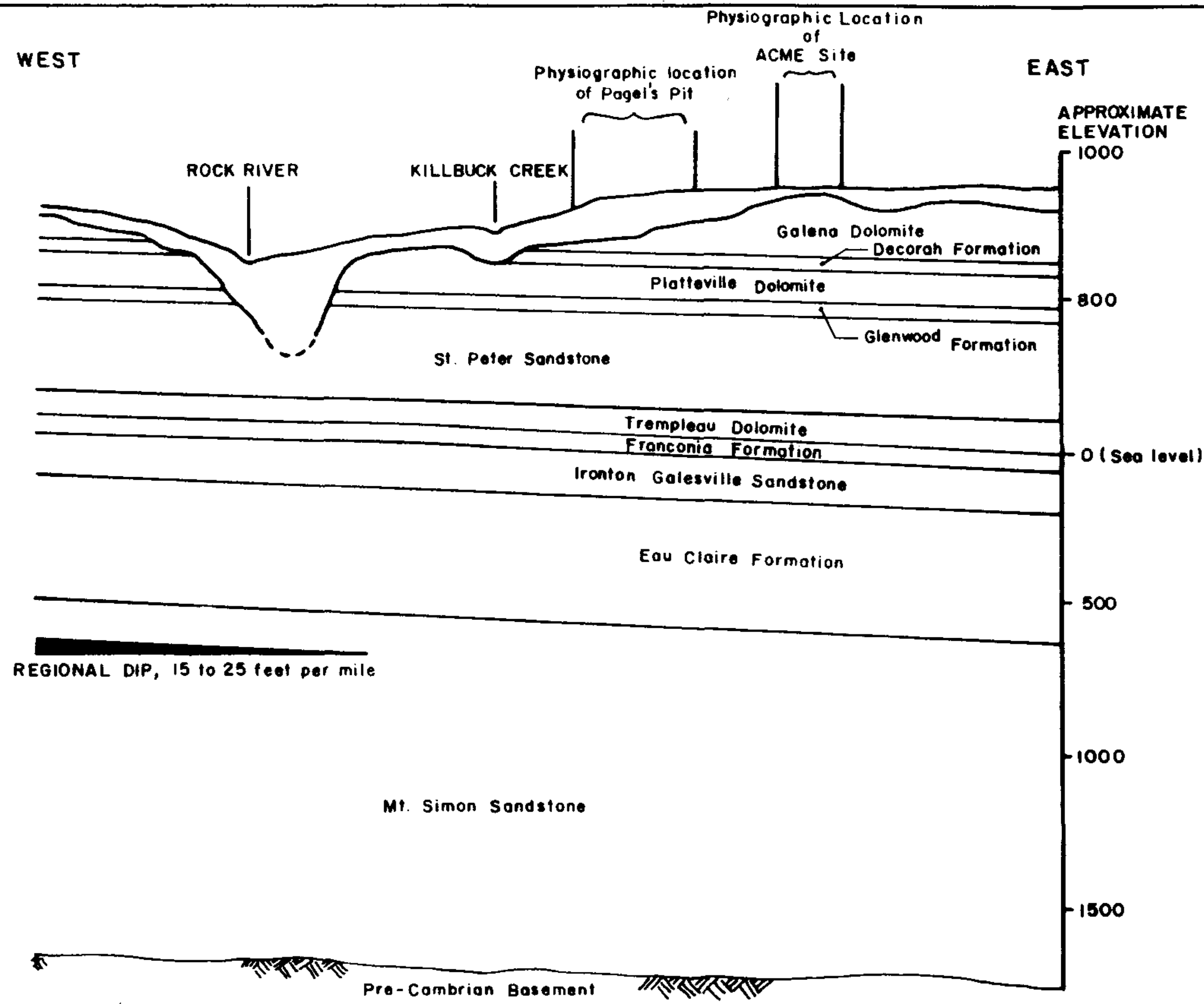
Figures 2.1 and 2.2 show the horizontal locations of wells and piezometers used in the RI. Table 2.1 includes data on the vertical placement of well screens and sand packs. The vertical setting appears in Figure 2.3 (redrawn after Jordan, Sept. 1984, Figure 10).

2.2.1 Vertical Sorting of Wells

The "shallow aquifer" in the Acme site vicinity is the Galena-Platteville. The aquifer base is approximately at elevation 500 feet above MSL in the west (near Killbuck Creek) and 480 feet in the east (near the eastern end of the Acme site). Water levels in the aquifer vary generally from around 705 feet in the west to 730 feet in the east. (Note that the western portion of the aquifer includes sand and gravel at shallower depths; but for brevity, the "shallow aquifer" will still be identified as the Galena-Platteville.) Thus the saturated thickness of the shallow aquifer varies from about 200 feet in the west to 250 feet in the east. The mid-depth of the aquifer is close to 600 feet above MSL throughout the area, and from Table 2.1 only a few wells are deep enough to approach this mid-depth elevation.

In fact, based on screen elevation, the 34 wells in Table 2.1 with screen elevations known have the following breakdown by depth:

Number of Wells	Vertical Category	Thickness for Category	Approximate Depth below Water Level of Screen (ft)
19	"Shallow"	0 - 1/10	0 - 13
12	"Intermediate"	1/10 - 2/10	20 - 45
3	"Deep"	3/10 - 5/10	68 - 112
34			



ACME SOLVENTS SUPERFUND SITE	E.A. HICKOK & ASSOCIATES HYDROLOGISTS-ENGINEERS MINNEAPOLIS-MINNESOTA	MAR. 1985
INTERPRETIVE GEOLOGIC PROFILE-SOUTHERN WINNEBAGO COUNTY (AFTER JORDAN, SEPT. 1984)		2.3

Of the above, two piezometers (P-8 and P-9) were not monitored for water quality. Thus 32 wells and piezometers have both water quality data and known screen depth. Figure 2.4 shows the location of these, distinguished by depth category, as well as the location of the 14 additional wells with water quality data but unknown depth.

It is obvious that any statements regarding contamination of deeper aquifers would be quite speculative, since even the lower half of the shallow aquifer was not monitored at all in the RI.

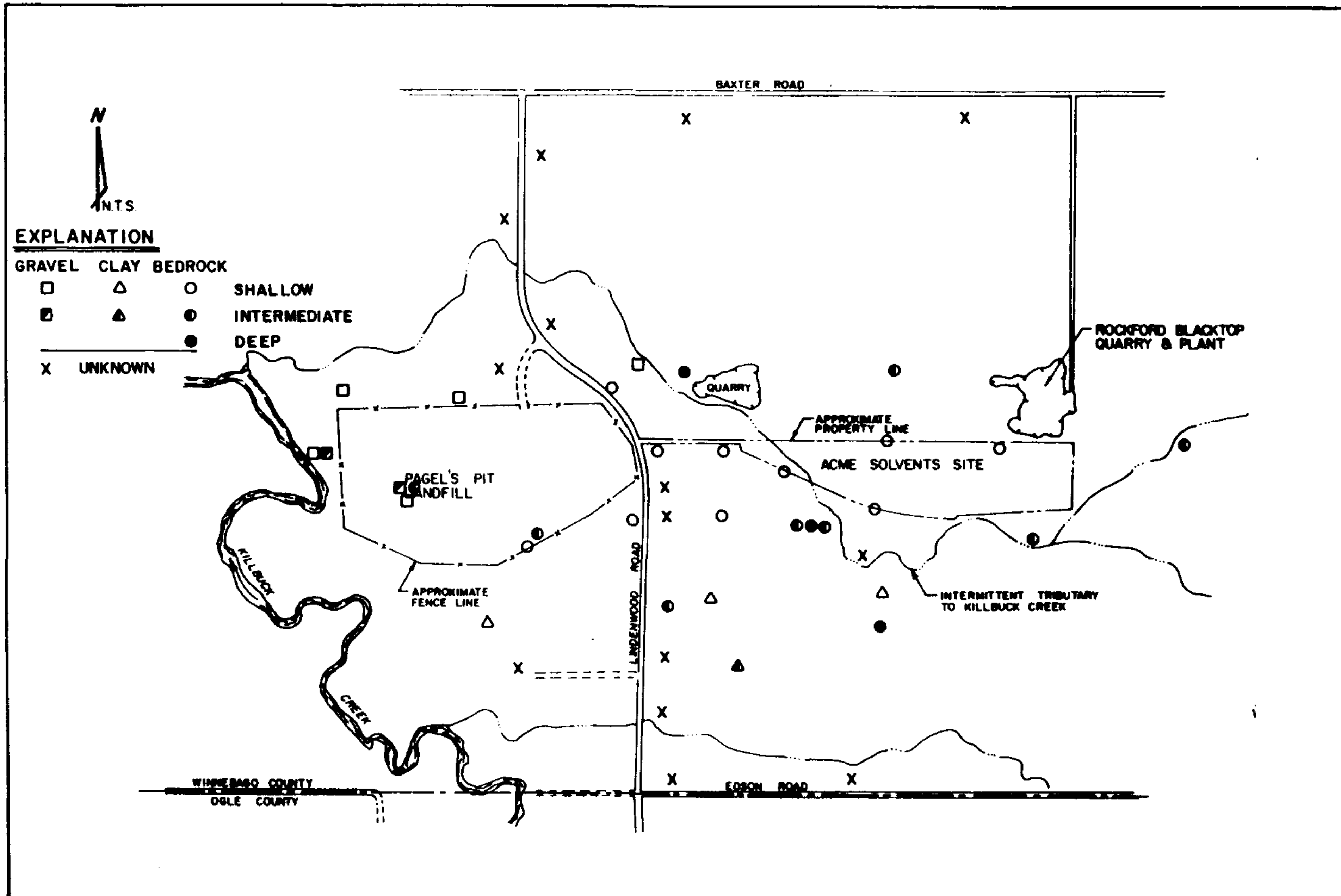
The three deep wells lie virtually on a straight line trending northwest-southwest (see Figure 2.4). (Again, the "deep" wells penetrate only the upper half of the shallow aquifer.) This linear configuration prevents a complete determination of the horizontal groundwater flow gradient in the stratum of the deep wells.

The wells in the Pagel's Pit area of intermediate depth also lie very close to a straight line (trending from west-northwest to east-southeast; see again Figure 2.4).

Total concentrations of volatile organics and of semivolatile organics are listed for each well in Table 2.2, sorted by depth and aquifer material where screened. Table 2.3 summarizes the data from Table 2.2. It is noteworthy that, of the bedrock wells, those of intermediate depth showed lower total volatiles concentrations than both the deep and the shallow wells. This suggests that the deeper contamination may have a different source from the shallow contamination.

2.2.2 Horizontal Sorting of Wells

The shallow groundwater flow pattern was used as a basis for horizontally sorting the monitored wells. Figure 2.5 shows the flow pattern as redrawn



ACME SOLVENTS SUPERFUND SITE	E.A. HICKOK & ASSOCIATES	MAR. 1985
LOCATION OF WELLS WITH WATER QUALITY DATA, BY DEPTH AND AQUIFER MATERIAL WHERE SCREENED	HYDROLOGISTS-ENGINEERS MINNEAPOLIS-MINNESOTA	2.4

TABLE 2.2

WELL WATER QUALITY BY DEPTH AND AQUIFER MATERIAL WHERE SCREENED

ACME SOLVENTS DISPOSAL SITE

Well	Concentration (micrograms per liter) Total Volatiles	Total Semivolatiles
SHALLOW WELLS:		
Gravel		
P-1	19	--
P-3	52	58
P-7	--	--
B-15	32	26
G-102	--	--
Mean (n=5)	21	17
Dectection Frequency (%)	60	40
Clay		
B-5	110	--
B-8	--	10
B-14	--	--
Mean (n=3)	37	3.3
Detection Frequency (%)	33	33
Bedrock		
B-1	130	48
B-2	110	--
B-4	>3,800	--
B-7	3.0	--
B-9	--	42
B-10	18	--
B-11	4.0	--
B-12	510	--
B-13	220	76
B-16	6.8	--
Mean-All Shallow Bedrock (n=10)	480	17
Mean-Excluding B-4 (n=9)	110	18
Detection Frequency (%)	90	30

TABLE 2.2 (continued)

WELL WATER QUALITY BY DEPTH AND AQUIFER MATERIAL WHERE SCREENED

ACME SOLVENTS DISPOSAL SITE

Well	Concentration (micrograms per liter) Total Volatiles	Total Semivolatiles
INTERMEDIATE WELLS:		
Gravel		
P-4	90	--
MW-106	42	220
Mean (n=2)	66	110
Dectection Frequency (%)	100	50
Clay		
B-3	--	--
Bedrock		
P-5	100	--
P-6	--	--
MW-101	--	--
MW-102	7.8	9.3
MW-103	3.7	10
MW-105	--	52
B-6S	--	--
J	--	--
Mean (N=8)	14	8.9
Detection Frequency (%)	38	38
DEEP WELLS:		
Bedrock		
MW-104	52	--
MW-107	5.6	--
B-6D	5.1	--
Mean (n=3)	21	--
Detection Frequency (%)	100	0

TABLE 2.2 (continued)

WELL WATER QUALITY BY DEPTH AND AQUIFER MATERIAL WHERE SCREENED

ACME SOLVENTS DISPOSAL SITE

Well	Concentration (micrograms per liter) Total Volatiles	Total Semivolatiles
WELLS OF UNKNOWN DEPTH:		
G-101	77	--
A	--	--
B	--	--
C	--	--
D	--	--
E	69	--
F	76	--
G	54	--
H	--	--
K	--	--
L	--	--
M	--	--
N	--	--
O	--	--
Mean (n=14)	20	--
Detection Frequency (%)	29	0

DATA SOURCE: E. C. Jordan (Sept. 1984).

NOTE: Only wells with both water quality data and known construction included (n=32 overall). Non-detections ("--") taken as zero in computations of mean values; the value ">3,800" taken as 3,800.

TABLE 2.3

SUMMARY OF WELL WATER QUALITY BY DEPTH AND AQUIFER MATERIAL

ACME SOLVENTS DISPOSAL SITE

Well Classification	Number of Wells	Total Volatiles Mean (ug/l)	Total Volatiles Det. Freq. (%)	Total Semivolatiles Mean (ug/l)	Total Semivolatiles Det. Freq (%)
SHALLOW WELLS:					
Gravel	5	21	60	17	40
Clay	3	37	33	3.3	33
Bedrock-All Shallow	10	480	90	17	30
Bedrock-Excluding B-4	9	110	--	18	--
ALL SHALLOW WELLS	18	280	72	14	33
SHALLOW-EXCLUDING B-4	17	71	71	15	35
INTERMEDIATE WELLS:					
Gravel	2	66	100	110	50
Clay	1	--	0	--	0
Bedrock	8	14	38	8.9	38
ALL INTERMEDIATE WELLS	11	22	45	26	36
DEEP WELLS:					
Bedrock	3	21	100	--	0
WELLS OF UNKNOWN DEPTH:	14	20	29	--	0
WELLS - ALL DEPTHS	46	120	54	12	22
WELLS - EXCLUDING B-4	45	40	53	12	22

DATA SOURCE: E. C. Jordan (Sept. 1984).

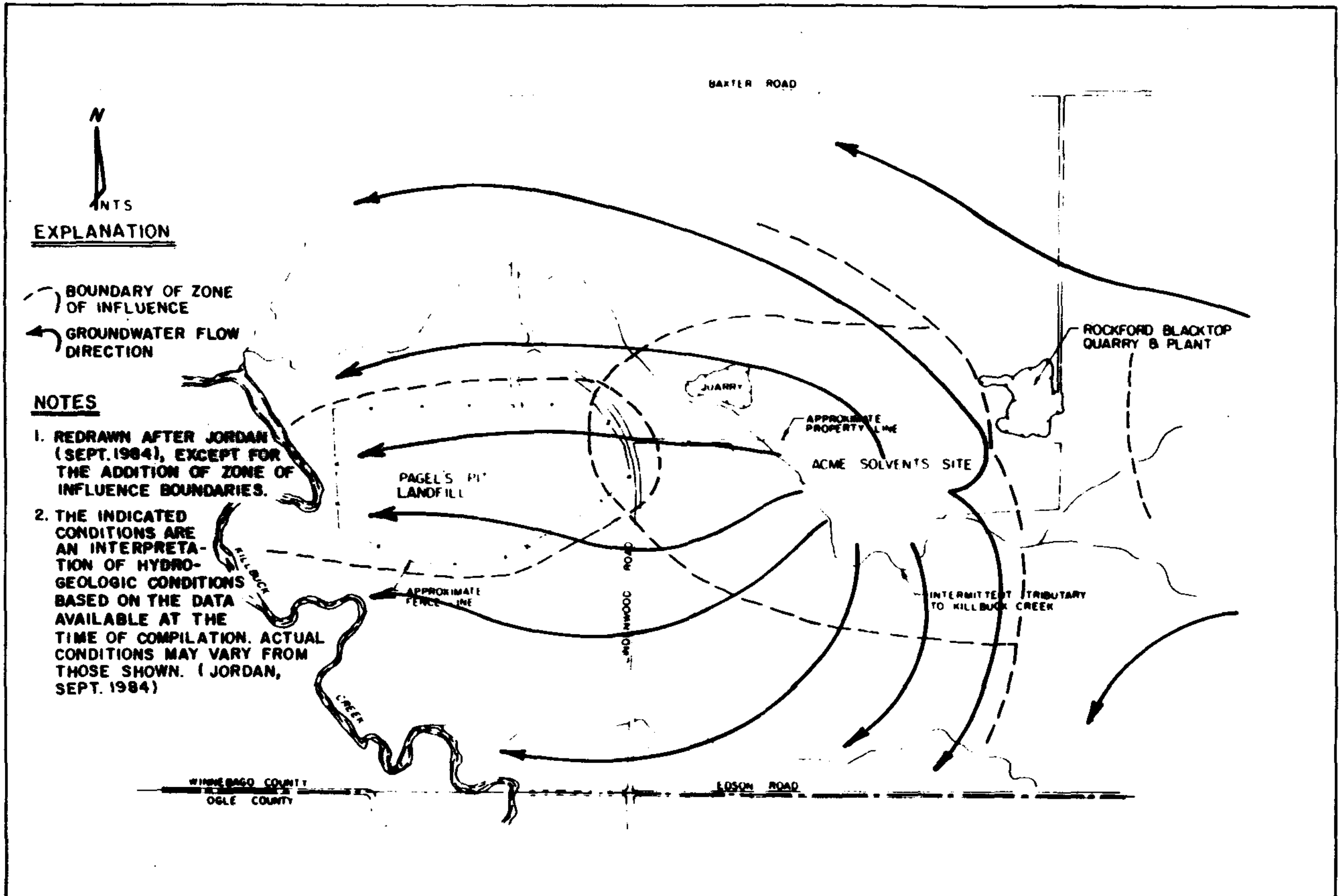
after Figure 21 in Jordan (Sept. 1984). As discussed in section 4.1, the flow pattern shown here appears to be a valid representation for the shallow wells. While it is not accurate for the strata corresponding to intermediate and deep wells, it is nevertheless adopted here as an approximate basis for horizontally sorting all wells having water quality data and known depth.

Accordingly, "zones of influence" consistent with the flow pattern are shown in Figure 2.5. The Acme site zone extends downgradient (i.e., north, west and south) from the site approximately 800 feet; this is approximately the maximum distance that contaminated groundwater could have traveled from the site since operations began there. The westerly extent intersects the Pagel's Pit zone of influence, thereby defining a boundary zone between the two sites. The easterly boundary of the Acme zone corresponds to the easterly limit of concentrated waste deposits on the site, as mapped by Jordan (Sept. 1984, Figure 24).

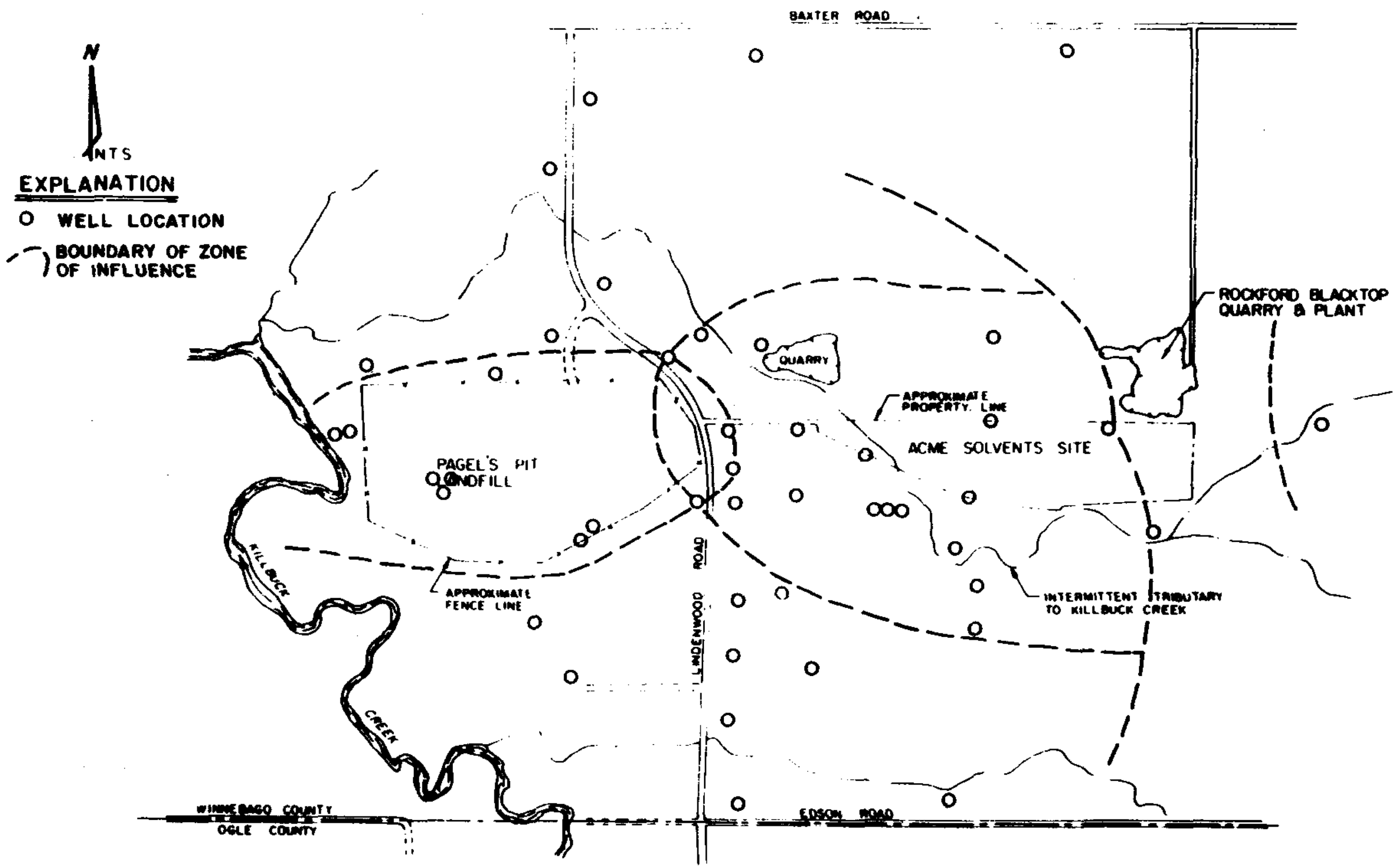
Note that groundwater flow lines at the Rockford Blacktop quarry and plant run more nearly north-south than east-west. It appears likely that flow lines diverge from this location, since bedrock is extensively exposed there, and there is a large area of negligible recharge located a short distance to the south. In other words, Rockford Blacktop's zone of influence probably extends both southward and northward from the quarry and plant.

Figure 2.6 superimposes the influence zone boundaries on the locations of the 46 wells with water quality data. The result is the following breakdown of wells:

Number of Wells	Horizontal Zones
1	Upgradient
0	Rockford Blacktop
2	Rockford Blackto-Acme Boundary
15	Acme Site
4	Acme-Pagel's Pit Boundary
8	Pagel's Pit
16	Outside the Above Influences
46	



ACME SOLVENTS SUPERFUND SITE	E.A. HICKOK & ASSOCIATES HYDROLOGISTS-ENGINEERS MINNEAPOLIS-MINNESOTA	MAR. 1985
GROUNDWATER QUALITY ZONES OF INFLUENCE		2.5



ACME SOLVENTS SUPERFUND SITE	E.A. HICKOK & ASSOCIATES	MAR. 1985
ZONES OF INFLUENCE AND WELL LOCATIONS	HYDROLOGISTS - ENGINEERS MINNEAPOLIS - MINNESOTA	2.6

Two wells are considered to be within a boundary zone between the Rockford Blacktop and Acme sites (wells B-1 and MW-103). The groundwater flow pattern implies that either site might influence these wells. And it is quite possible that both sites influence them in different seasons.

Notice that <u>no</u> well is clearly within the Rockford Blacktop zone of influence. So it is impossible to determine from existing data whether Rockford Blacktop is or is not a source of groundwater contamination in the general vicintiy. The RI report is thus inconsistent and erroneous in concluding that Rockford Blacktop is not a contaminant source.

Table 2.4 presnts well water quality data sorted horizontally and by depth. It is strinking that volatile organics were not detected in any of the three intermediate-depth wells in the Acme zone. By contrast, all three deep wells in the Acme zone exhibited measurable volatiles. Again, this suggests that contamination in the stratum of the deep wells originates elsewhere.

Also of note in Table 2.4 are the measurable concentrations of both volatile and semivolatile organics in the upgradient well and in the two Rockford Blacktop-Acme site boundary zone wells. These findings are consistent with the existence of upgradient contaminant sources, possibly including Rockford Blacktop.

Table 5 gives a summary of the data in Table 2.4.

2.2.3 Water Quality in Vertical Cross-Sectinos

Figure 2.7 shows E. C. Jordan's interpretation of vergical groundwater flow (redrawn after Figure 22 in: Jordan, Sept. 1984). As discussed in section 4.2, the flow pattern shown here appears reasonably to represent conditions observed on May 4, 1984, but not during March and April 1984 (encompassing all other dates with extensive observations). Under the conditions shown, it is plausible

TABLE 2.4

WELL WATER QUALITY BY HORIZONTAL SORTING AND DEPTH

ACME SOLVENTS DISPOSAL SITE

Well	Concentration (micrograms per liter) Total Volatiles	Total Semivolatiles
UPGRADIENT:		
Intermediate - Bedrock:		
MW-102 (n=1)	7.8	9.3
ROCKFORD BLACKTOP:		
No Wells (n=0)	----------- Not Available	-----------
ROCKFORD BL. - ACME:		
Shallow - Bedrock:		
B-1 (n=1)	130	48
Intermediate - Bedrock:		
MW-103 (n=1)	3.7	10
ACME SITE:		
Shallow - Gravel:		
G-102	--	--
Shallow - Clay:		
B-5	110	--
Shallow - Bedrock:		
B-2	110	--
B-4	>3,800	--
B-7	3.0	--
B-9	--	42
B-16	6.8	--
Mean - Shallow (n=7)	580	6.0
Mean - Excluding B-4 (n=6)	38	7.0
Detection Frequency (%)	71	14

TABLE 2.4 (continued)

WELL WATER QUALITY BY HORIZONTAL SORTING AND DEPTH

ACME SOLVENTS DISPOSAL SITE

Well	Concentration (micrograms per liter) Total Volatiles	Total Semivolatiles
Intermediate - Bedrock:		
B-6S	--	--
MW-101	--	--
MW-105	--	52
Mean - Intermediate (n=3)	--	7.4
Detection Frequency (%)	0	33
Deep - Bedrock:		
B-6D	5.1	--
MW-104	52	--
MW-107	5.6	--
Mean - Deep (n=3)	21	--
Detection Frequency (%)	100	0
Unknown Depth:		
G-101 (gravel)	77	--
H	--	--
Mean - Unknown (n=2)	38	--
Detection Frequency (%)	50	0
ACME - PAGEL'S PIT:		
Shallow - Bedrock:		
B-10	18	--
B-11	4.0	--
B-12	510	--
Mean - Shallow (n=3)	180	--
Detection Frequency (%)	100	0
Unknown Depth:		
G (n=1)	54	--

TABLE 2.4 (continued)

WELL WATER QUALITY BY HORIZONTAL SORTING AND DEPTH

ACME SOLVENTS DISPOSAL SITE

Well	Concentration (micrograms per liter) Total Volatiles	Total Semivolatiles
PAGEL'S PIT:		
Shallow - Gravel:		
B-15	32	26
P-1	19	--
P-3	52	58
Shallow - Bedrock:		
B-13	220	76
Mean - Shallow (n=4)	81	40
Detection Frequency (%)	100	75
Intermediate - Gravel:		
MW-106	42	220
P-4	90	--
P-5	100	--
Intermediate - Bedrock:		
P-6	--	--
Mean - Intermediate (n=4)	58	55
Detection Frequency (%)	75	25
OUTSIDE ABOVE INFLUENCES:		
Shallow - Clay:		
B-8	--	10
B-14	--	--
P-7	--	--
Mean - Shallow (n=3)	--	3.3
Detection Frequency (%)	0	33

TABLE 2.4 (continued)

WELL WATER QUALITY BY HORIZONTAL SORTING AND DEPTH

ACME SOLVENTS DISPOSAL SITE

Well	Concentration (micrograms per liter) Total Volatiles	Total Semivolatiles
Intermediate - Clay:		
B-3	--	--
Intermediate - Bedrock:		
J	--	--
Mean - Intermediate (n=2)	--	--
Detection Frequency (%)	0	0
Unknown Depth:		
A	--	--
B	--	--
C	--	--
D	--	--
E	69	--
F	76	--
J	--	--
L	--	--
M	--	--
N	--	--
O	--	--
Mean - Unknown (n=11)	13	--
Detection Frequency (%)	18	0

DATA SOURCE: E. C. Jordan (Sept. 1984).

TABLE 2.5

SUMMARY OF WELL WATER QUALITY BY HORIZONTAL SORTING AND DEPTH

ACME SOLVENTS DISPOSAL SITE

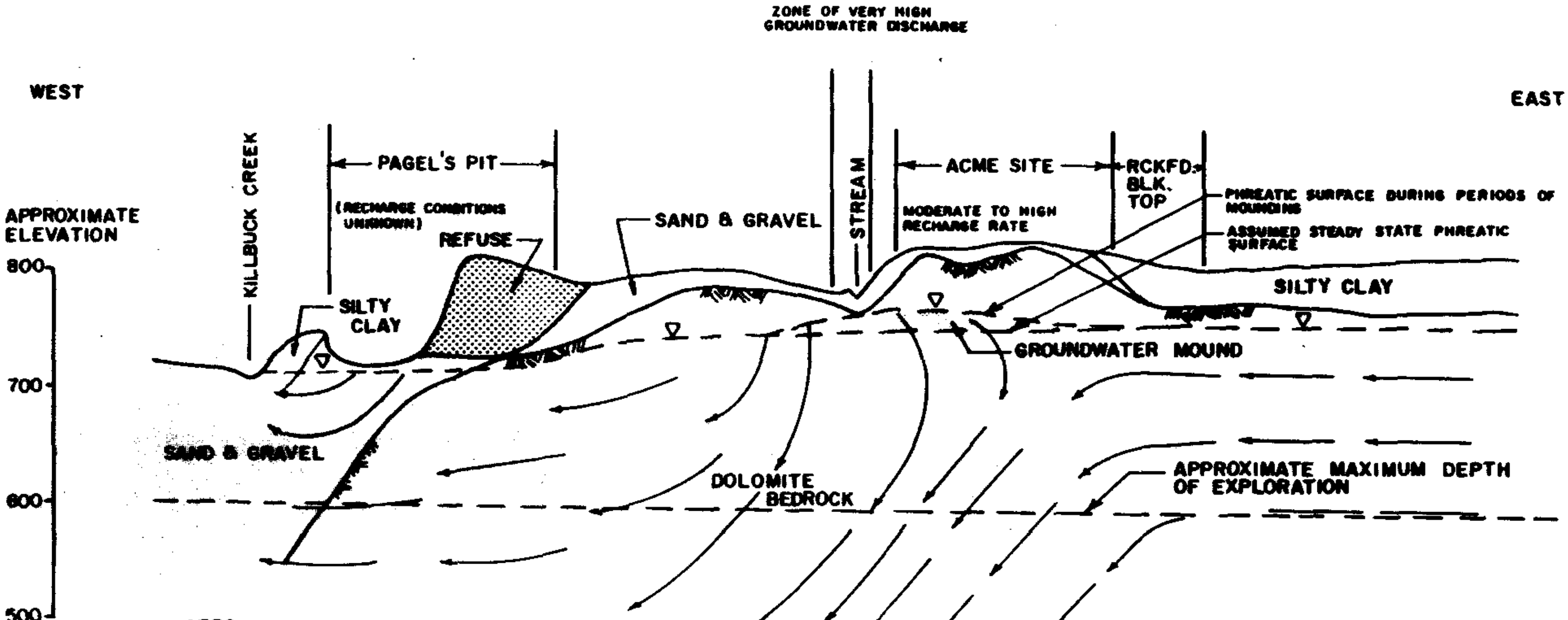
Well Classification	Number of Wells	Total Volatiles Mean (ug/l)	Total Volatiles Det. Freq. (%)	Total Semivolatiles Mean (ug/l)	Total Semivolatiles Det. Freq (%)
UPGRADIENT: Intermediate	1	7.8	--	9.3	--
ROCKFORD BLACKTOP: No Wells	0	Not Available			
ROCKF. BL. - ACME:					
Shallow	1	130	--	48	--
Intermediate	1	3.7	--	10	--
ALL ROCKF. BL. - AMCE WELLS	2	67	100	29	100
ACME SITE:					
Shallow - All Wells	7	580	71	6.0	14
Shallow - Excluding B-4	6	38	67	7.0	17
Intermediate	3	--	0	7.4	33
Deep	3	21	100	--	0
Unknown Depth	2	38	50	--	0
ALL ACME WELLS	15	280	60	6.3	13
ACME - EXCLUDING B-4	14	26	57	6.7	14
ACME - PAGEL'S PIT:					
Shallow	3	180	100	--	0
Unknown Depth	1	54	--	--	--
ALL ACME - PAGEL'S PIT WELLS	4	150	100	--	0

TABLE 2.5 (continued)

SUMMARY OF WELL WATER QUALITY BY HORIZONTAL SORTING AND DEPTH

ACME SOLVENTS DISPOSAL SITE

Well Classification	Number of Wells	Total Volatiles Mean (ug/l)	Total Volatiles Det. Freq. (%)	Total Semivolatiles Mean (ug/l)	Total Semivolatiles Det. Freq (%)
P'GEL'S PIT:					
Shallow	4	81	100	40	75
Intermediate	4	58	75	55	25
ALL PAGEL'S PIT WELLS	8	69	88	48	50
OUTSIDE ABOVE INFLUENCES:					
Shallow	3	--	0	3.3	33
Intermediate	2	--	0	--	0
Unknown Depth	11	13	18	--	0
A L OUTSIDE WELLS	16	9.1	12	0.6	6
ALL WELLS	46	120	54	12	22
WELLS EXCLUDING B-4	45	40	53	12	22



NOTES

1. REDRAWN AFTER JORDAN (SEPT. 1984), EXCEPT FOR ADDITION OF ROCKFORD BLACKTOP'S APPROXIMATE LOCATION.
2. APPROXIMATE VERTICAL EXAGGERATION - 100:1
3. THE INDICATED CONDITIONS ARE AN INTERPRETATION OF HYDROGEOLOGIC CONDITIONS BASED ON THE DATA AVAILABLE AT THE TIME OF COMPILATION. ACTUAL CONDITIONS MAY VARY FROM THOSE SHOWN.

EXPLANATION

- POTENTIOMETRIC SURFACE
- BEDROCK SURFACE
- GROUNDWATER FLOW PATH

APPROX. SCALE

0 500 1000 FEET

ACME SOLVENTS SUPERFUND SITE	E.A. HICKOK & ASSOCIATES HYDROLOGISTS - ENGINEERS MINNEAPOLIS - MINNESOTA	MAR. 1985
E. C. JORDAN'S INTERPRETATION OF VERTICAL GROUNDWATER FLOW		2.7

that contaminants originating from upgradient of the Acme site will move downward below the site to greater depths in the aquifer. This gives a possible explanation for the deep contamination observed in the Acme site zone, in spite of the absence of volatile organics there at intermediate depths.

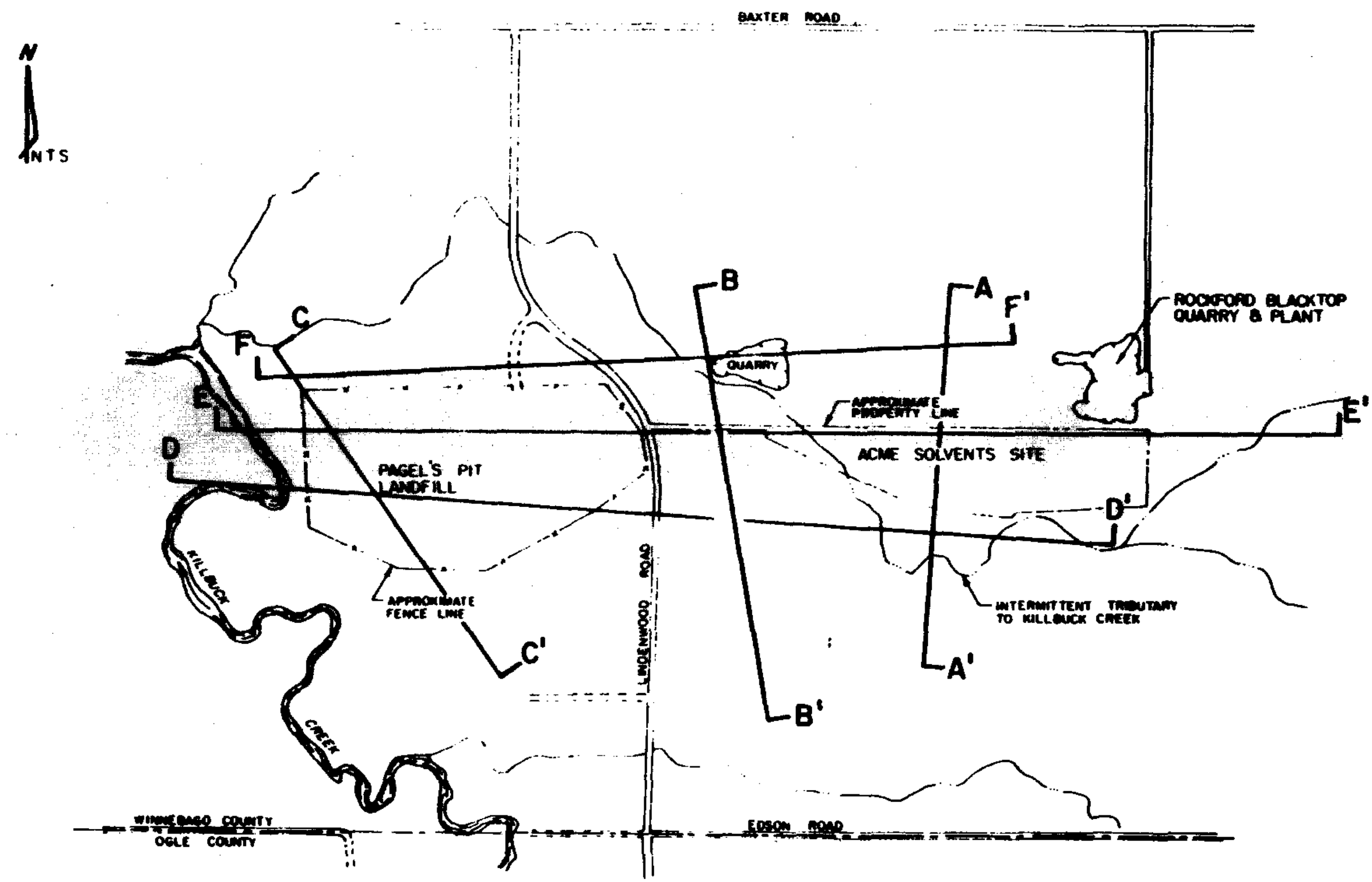
Vertical geologic cross-sections (see Figure 2.8 for locations) provide another view of the well water quality data (Figures 2.9 to 2.14). Note in particular that wells MW-103 and B-6D (Figure 2.12) may reflect the downward movement of contaminants originating upgradient from the Acme site, as discussed in the preceding paragraph.

2.2.4 Water Quality Mapped Horizontally and by Depth

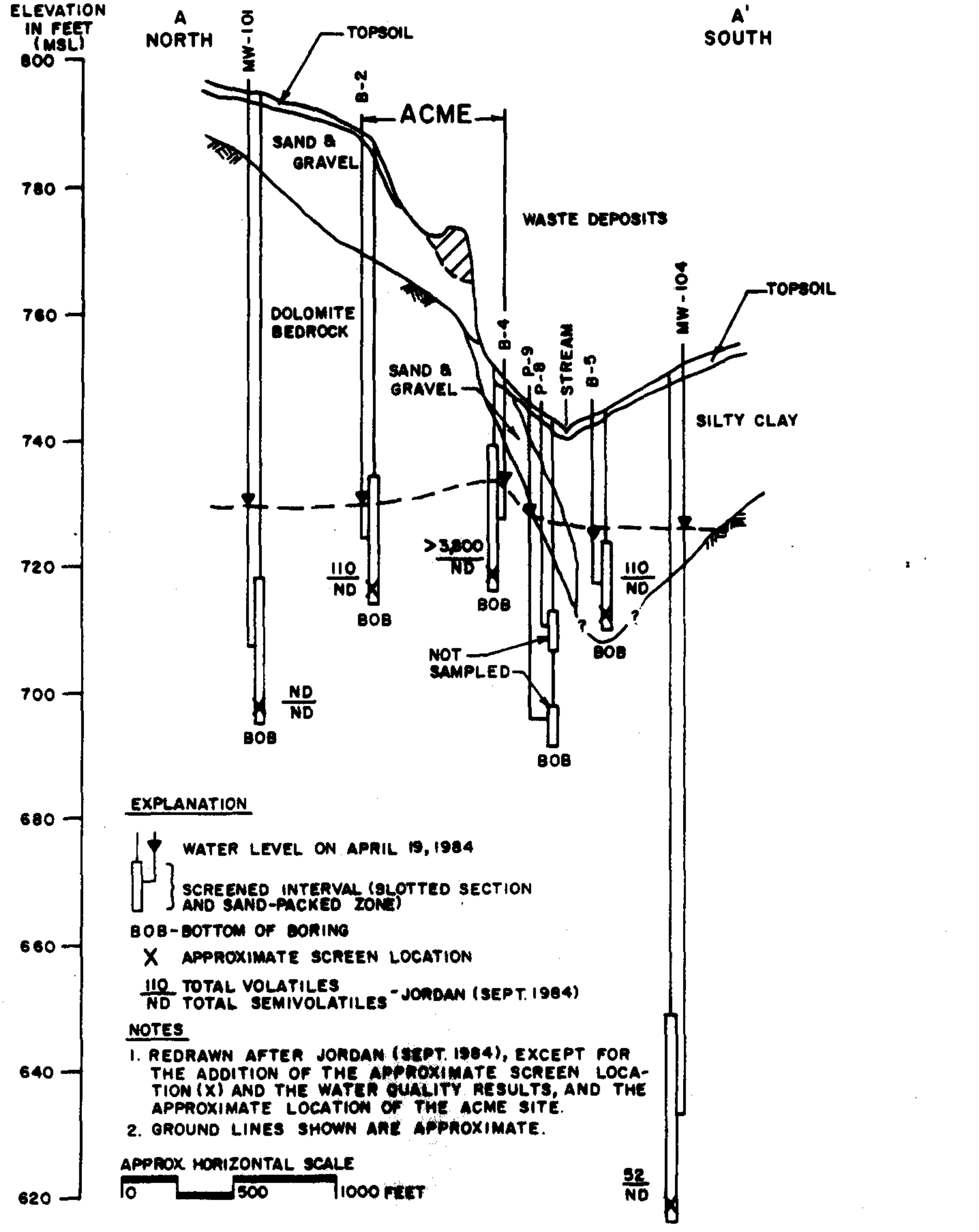
Figures 2.15 to 2.17 map the concentrations of total volatiles for the shallow, intermediate and deep wells, respectively. Data for the shallow wells (Figure 2.15) confirm that both Pagel's Pit and the Acme site are contaminant sources. The mapped data also suggest that Rockford Blacktop may be a contaminant source. It is evident that additional shallow wells are needed in the vicinity of that site as well as upgradient from the Acme site in order to evaluate the contaminant pattern there at shallow depth.

The wells of intermediate depth reveal a surprising pattern of contaminatin (Figure 2.16). While Pagel's Pit again clearly shows itself to be a contaminant source, the Acme site appears not to be a contaminant source at all. Instead, the data indicate an upgradient source of volatile orgnics at intermediate depth.

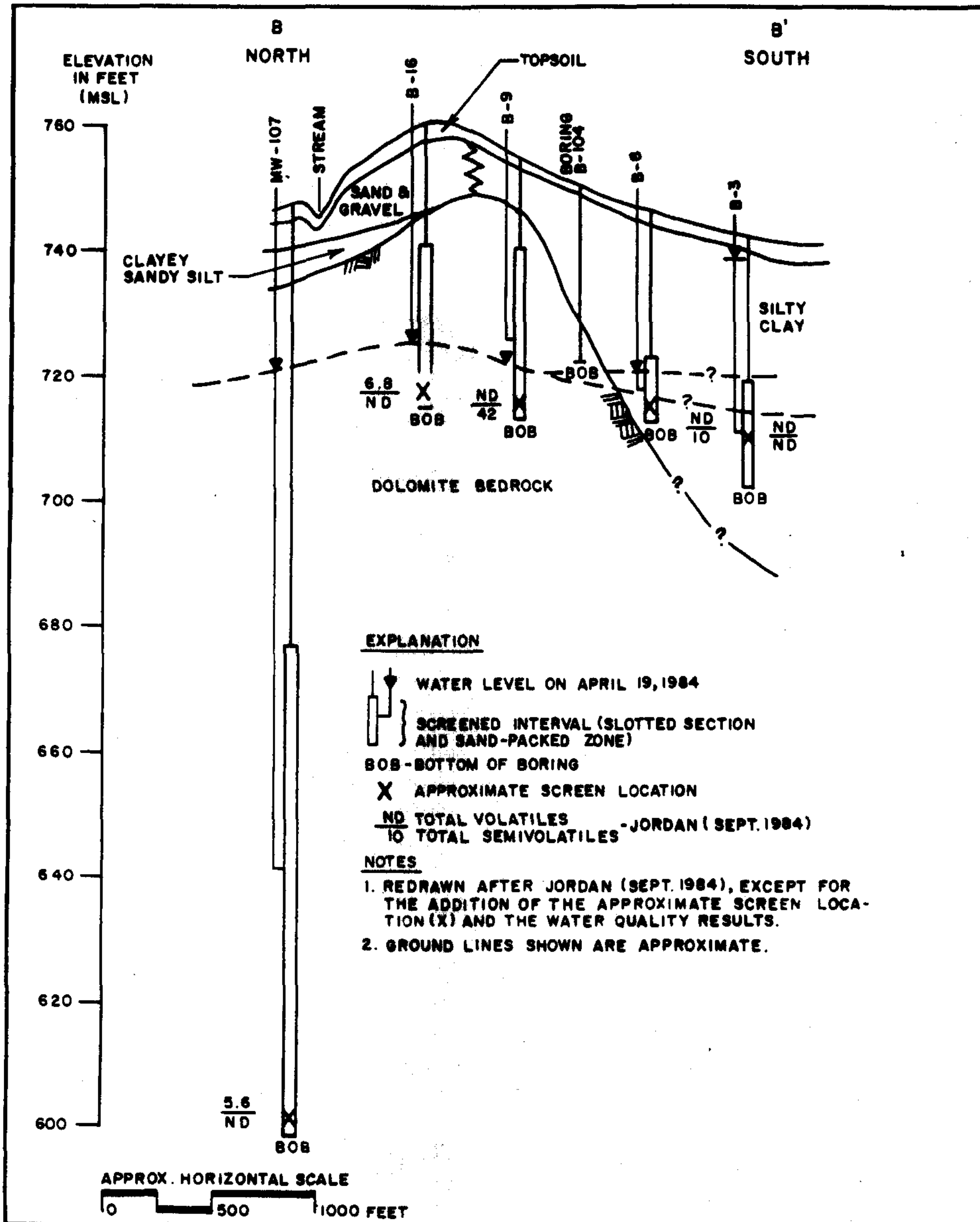
Comparison of the data in Figures 2.15 and 2.16 for the region immediately south of the Acme site suggests that volatiles emanating from the Acme site remain at shallow depth -- i.e., in approximately the upper one-tenth of the aquifer thickness.



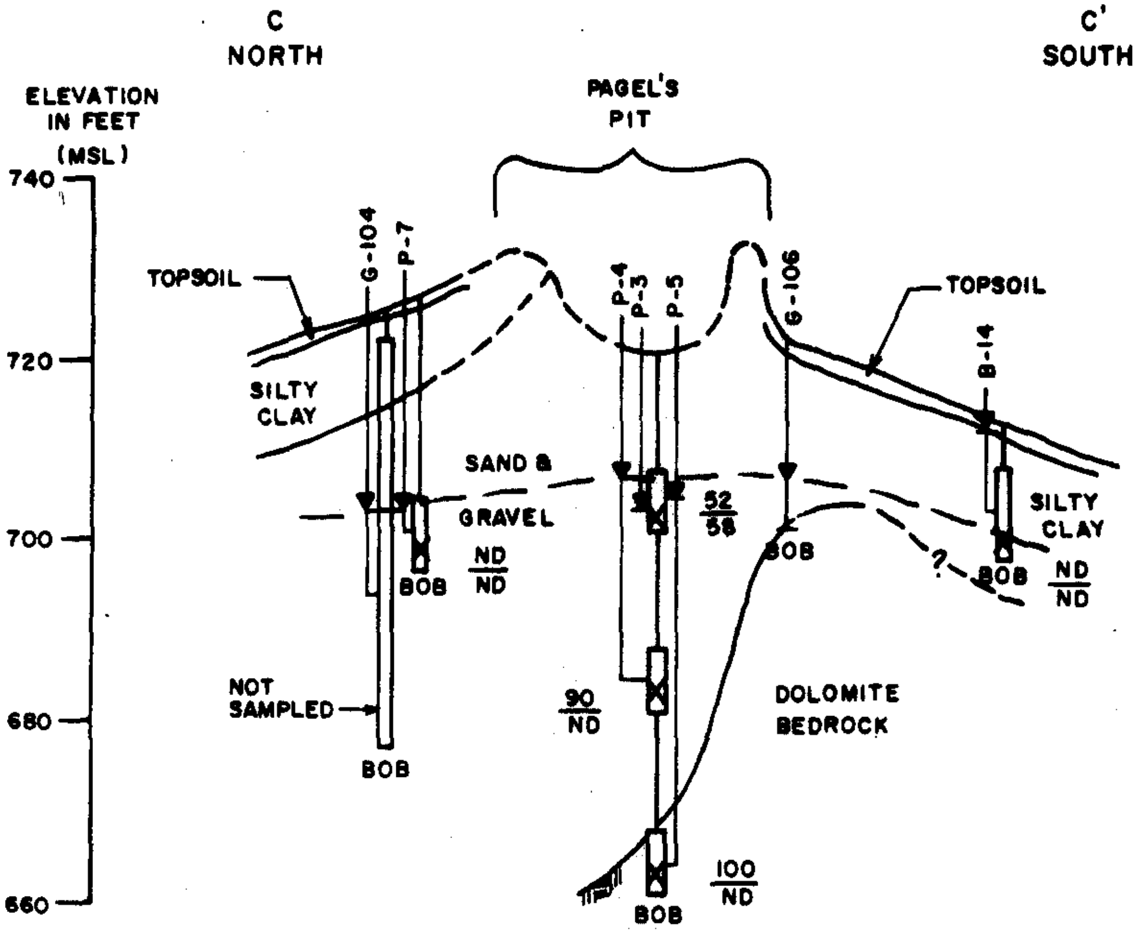
ACME SOLVENTS SUPERFUND SITE	E.A. HICKOK & ASSOCIATES HYDROLOGISTS-ENGINEERS MINNEAPOLIS-MINNESOTA	MAR. 1985
LOCATIONS OF GEOLOGIC CROSS-SECTIONS		2.8



ACME SOLVENTS SUPERFUND SITE GROUNDWATER QUALITY IN CROSS-SECTION A-A'	E.A. HICKOK & ASSOCIATES HYDROLOGISTS-ENGINEERS MINNEAPOLIS-MINNESOTA	MAR. 1985 2.9



ACME SOLVENTS SUPERFUND SITE	E.A. HICKOK & ASSOCIATES HYDROLOGISTS - ENGINEERS MINNEAPOLIS - MINNESOTA	MAR. 1985
GROUNDWATER QUALITY IN CROSS-SECTION B - B'		2.10



EXPLANATION

WATER LEVEL ON APRIL 19,1984

SCREENED INTERVAL (SLOTTED SECTION AND SAND-PACKED ZONE)

BOB - BOTTOM OF BORING

X APPROXIMATE SCREEN LOCATION

52 TOTAL VOLATILES / 58 TOTAL SEMIVOLATILES - JORDAN (SEPT. 1984)

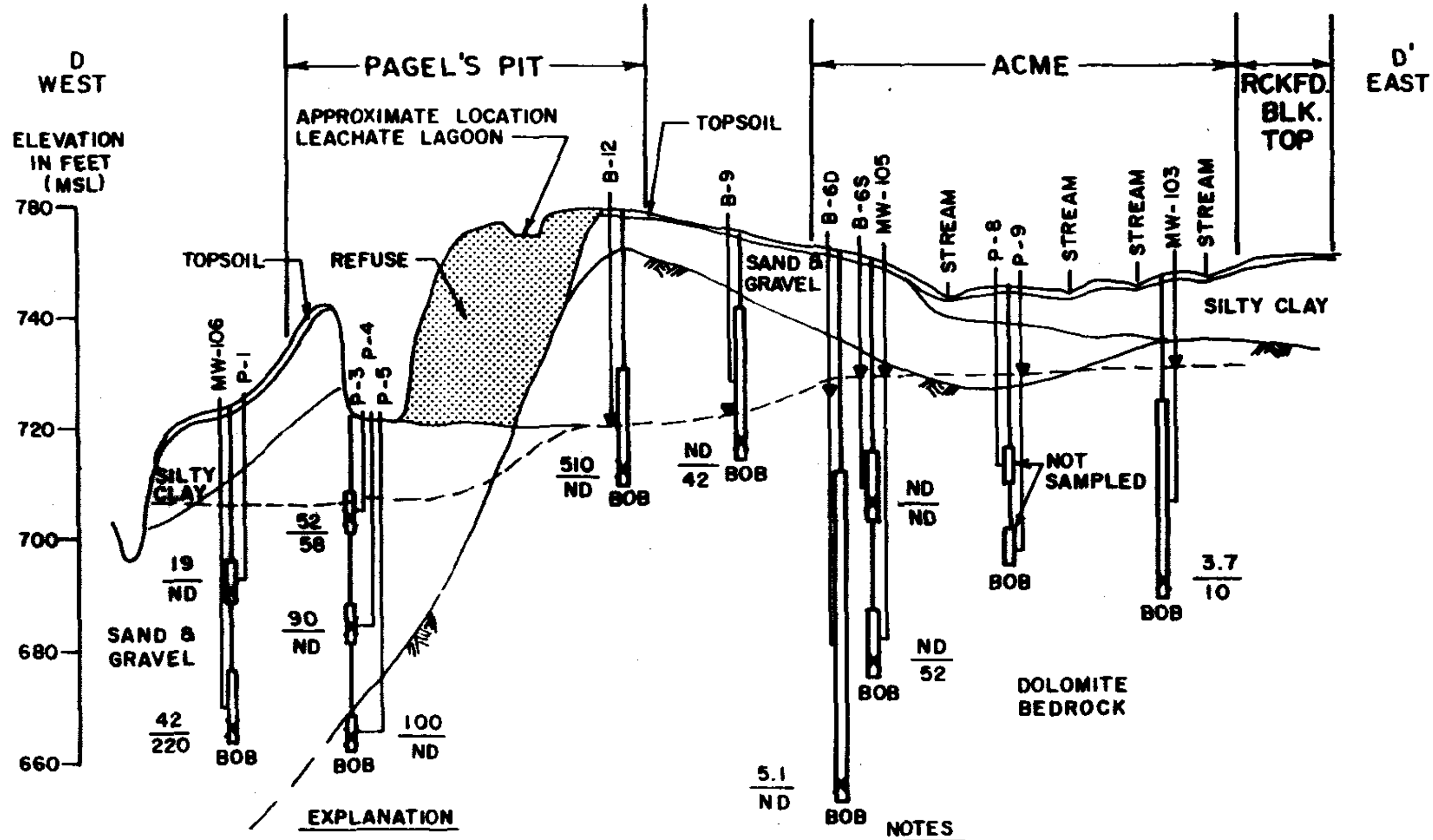
NOTES

1. REDRAWN AFTER JORDAN (SEPT. 1984), EXCEPT FOR THE ADDITION OF THE APPROXIMATE SCREEN LOCATION (X) AND THE WATER QUALITY RESULTS.
2. GROUND LINES SHOWN ARE APPROXIMATE.

APPROX. HORIZONTAL SCALE

0 500 1000 FEET

ACME SOLVENTS SUPERFUND SITE	E.A. HICKOK & ASSOCIATES HYDROLOGISTS-ENGINEERS MINNEAPOLIS-MINNESOTA	MAR. 1985
GROUNDWATER QUALITY IN CROSS-SECTION C-C'		2.11



EXPLANATION

WATER LEVEL ON APRIL 19, 1984

SCREENED INTERVAL (SLOTTED SECTION AND SAND-PACKED ZONE)

BOB-BOTTOM OF BORING

X APPROXIMATE SCREEN LOCATION

ND TOTAL VOLATILES / 42 TOTAL SEMIVOLATILES -JORDAN (SEPT. 1984)

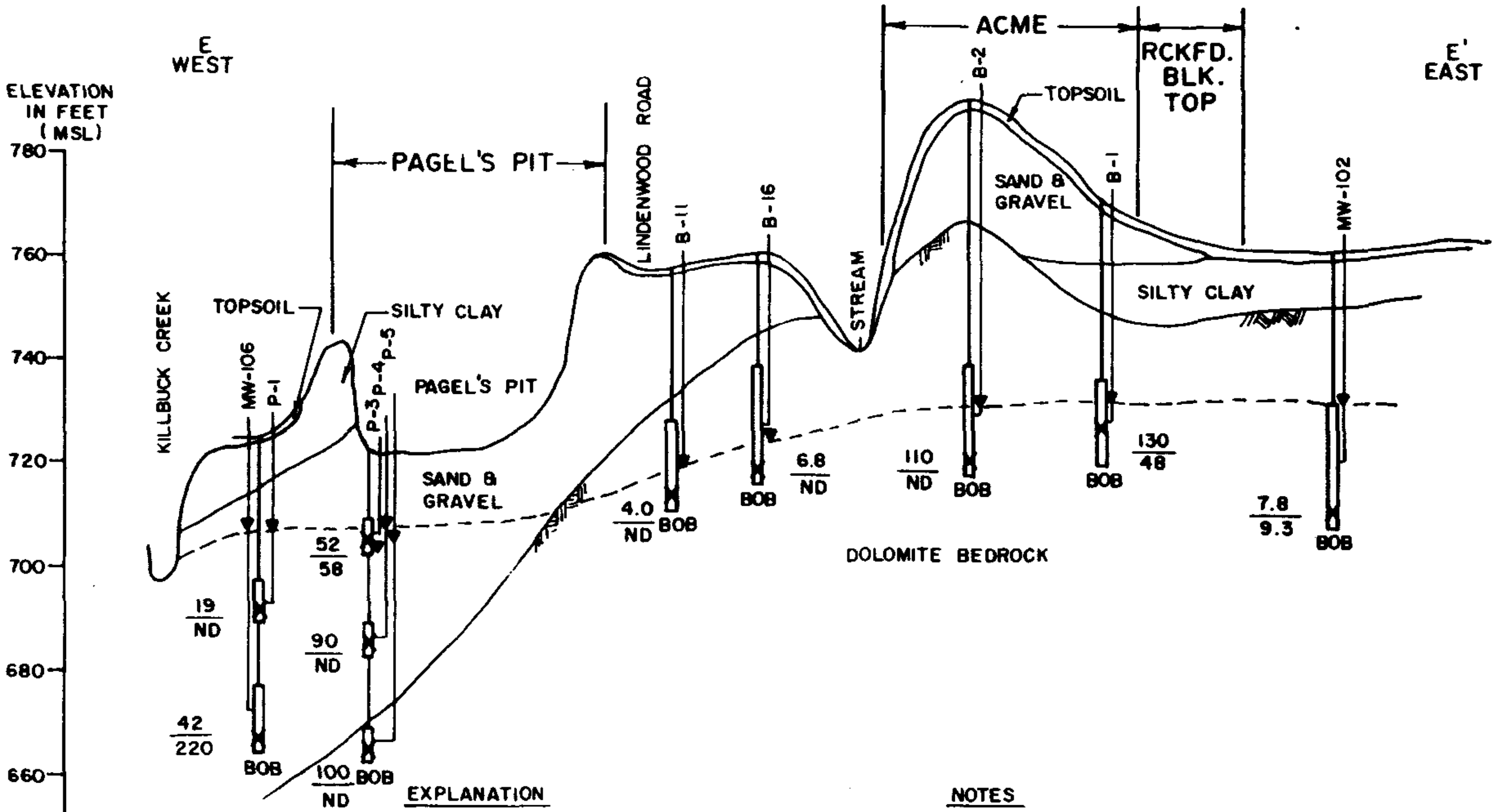
APPROX. HORIZONTAL SCALE

0 500 1000 FEET

NOTES

1. REDRAWN AFTER JORDAN (SEPT. 1984), EXCEPT FOR THE ADDITION OF THE APPROXIMATE SCREEN LOCATION (X) AND THE WATER QUALITY RESULTS, AND THE APPROXIMATE LOCATION OF PAGEL'S PIT, ACME SITE, AND ROCKFORD BLACKTOP.
2. GROUND LINES SHOWN ARE APPROXIMATE.

ACME SOLVENTS SUPERFUND SITE	E.A. HICKOK & ASSOCIATES HYDROLOGISTS-ENGINEERS MINNEAPOLIS-MINNESOTA	MAR. 1985
GROUNDWATER QUALITY IN CROSS-SECTION D-D'		2.12



EXPLANATION

WATER LEVEL ON APRIL 19, 1984

SCREENED INTERVAL (SLOTTED SECTION AND SAND-PACKED ZONE)

BOB - BOTTOM OF BORING

X APPROXIMATE SCREEN LOCATION

$\frac{52}{58}$ TOTAL VOLATILES / TOTAL SEMIVOLATILES - JORDAN (SEPT. 1984)

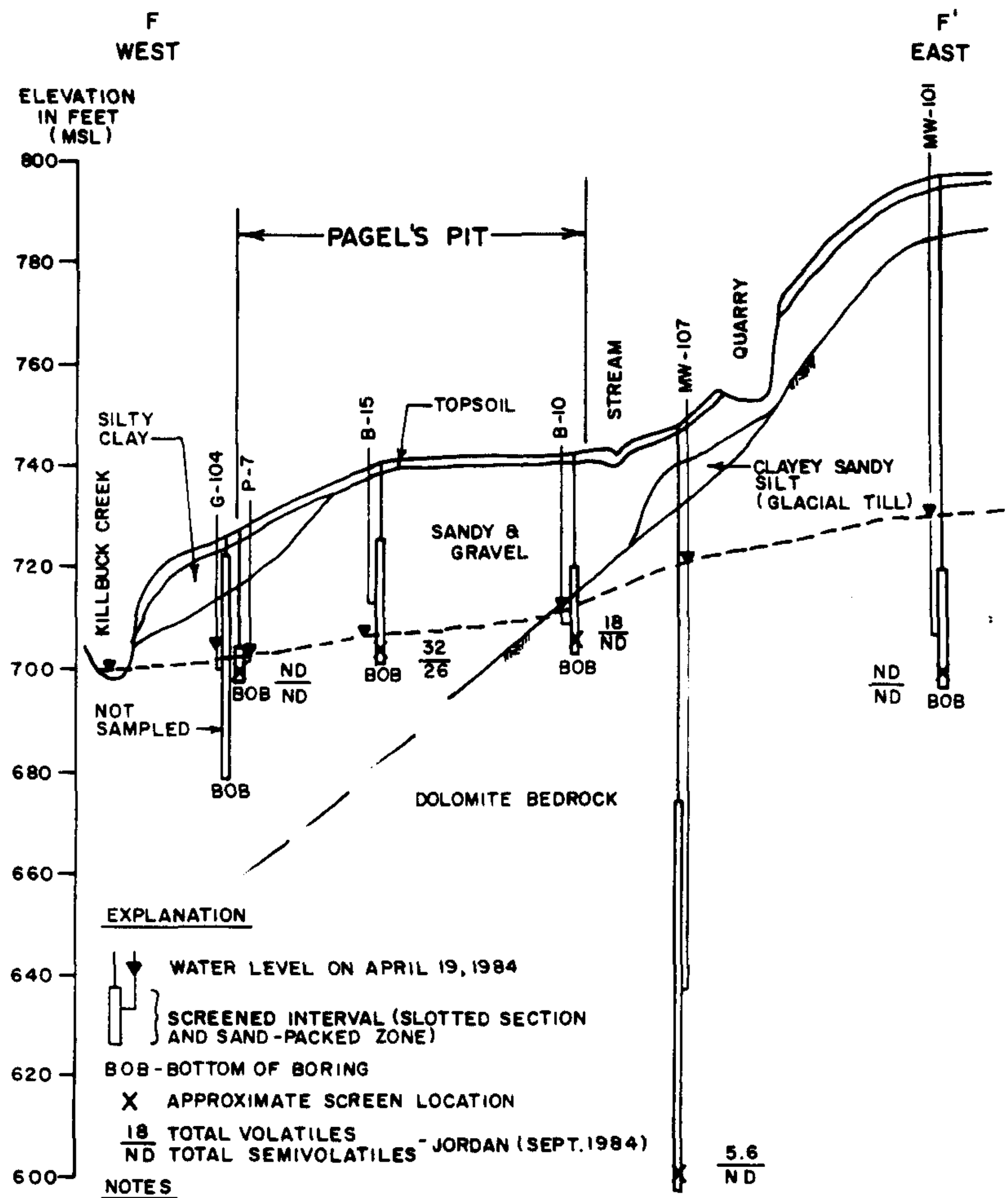
APPROX. HORIZONTAL SCALE

0 500 1000 FEET

NOTES

1. REDRAWN AFTER JORDAN (SEPT. 1984), EXCEPT FOR THE ADDITION OF THE APPROXIMATE SCREEN LOCATION (X) AND THE WATER QUALITY RESULTS, AND THE APPROXIMATE LOCATION OF PAGEL'S PIT, ACME SITE, AND ROCKFORD BLACKTOP.
2. GROUND LINES SHOWN ARE APPROXIMATE.

ACME SOLVENTS SUPERFUND SITE	E.A. HICKOK & ASSOCIATES HYDROLOGISTS-ENGINEERS MINNEAPOLIS-MINNESOTA	MAR. 1985
GROUNDWATER QUALITY IN CROSS-SECTION E-E'		2.13



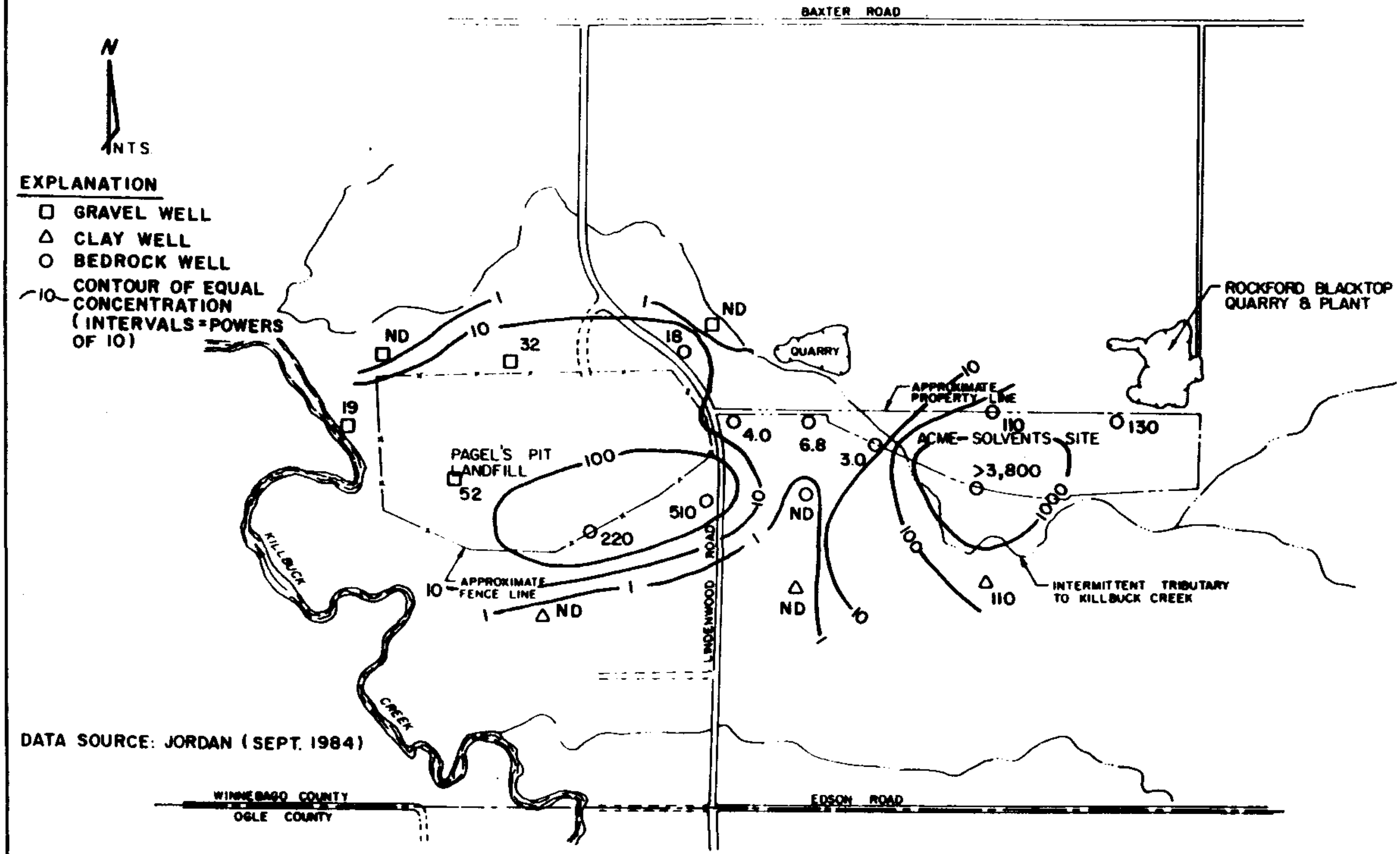
NOTES

1. REDRAWN AFTER JORDAN (SEPT. 1984), EXCEPT FOR THE ADDITION OF THE APPROXIMATE SCREEN LOCATION (X) AND THE WATER QUALITY RESULTS, AND THE APPROXIMATE LOCATION OF PAGEL'S PIT.
2. GROUND LINES SHOWN ARE APPROXIMATE.

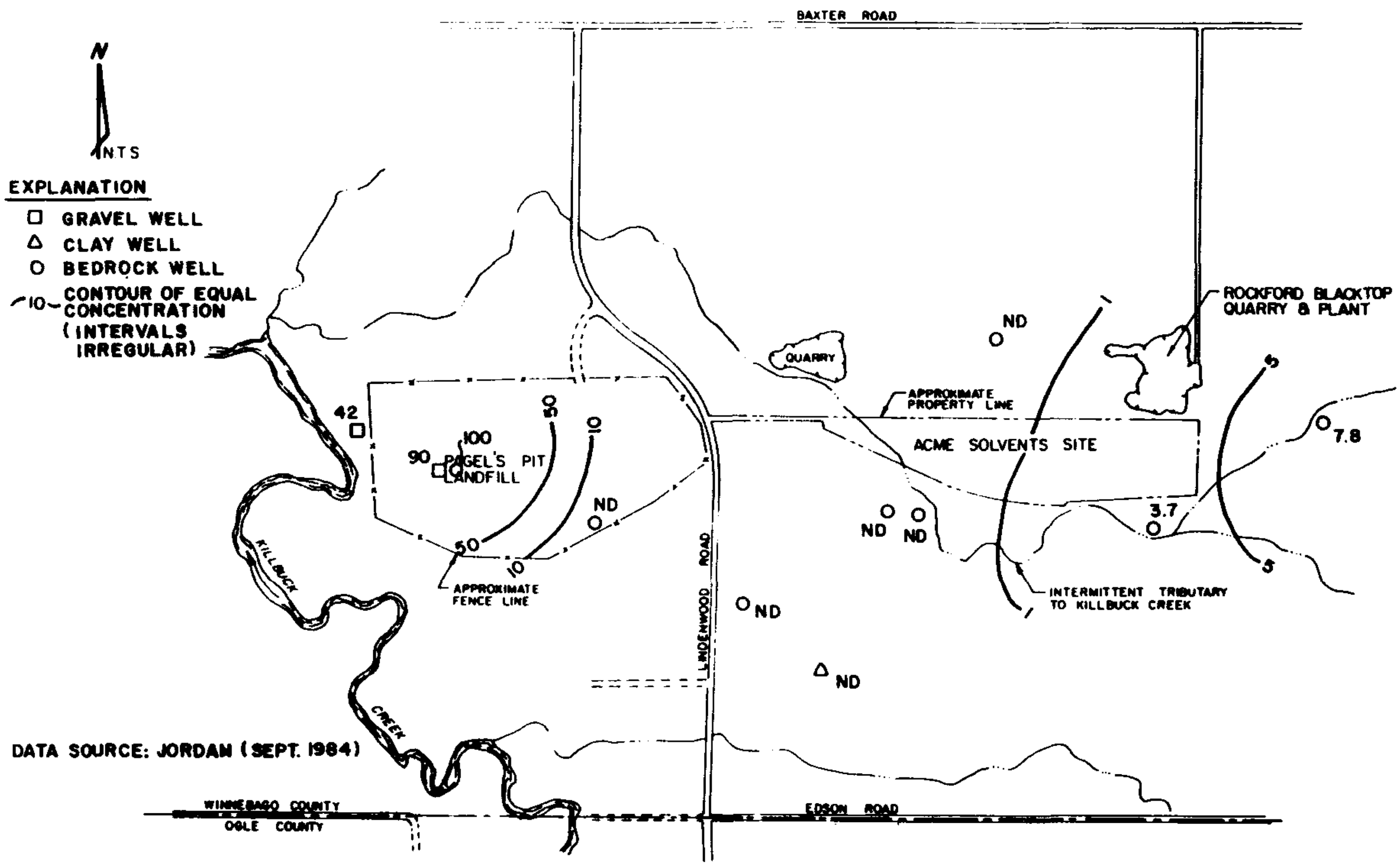
APPROX. HORIZONTAL SCALE

0 500 1000 FEET

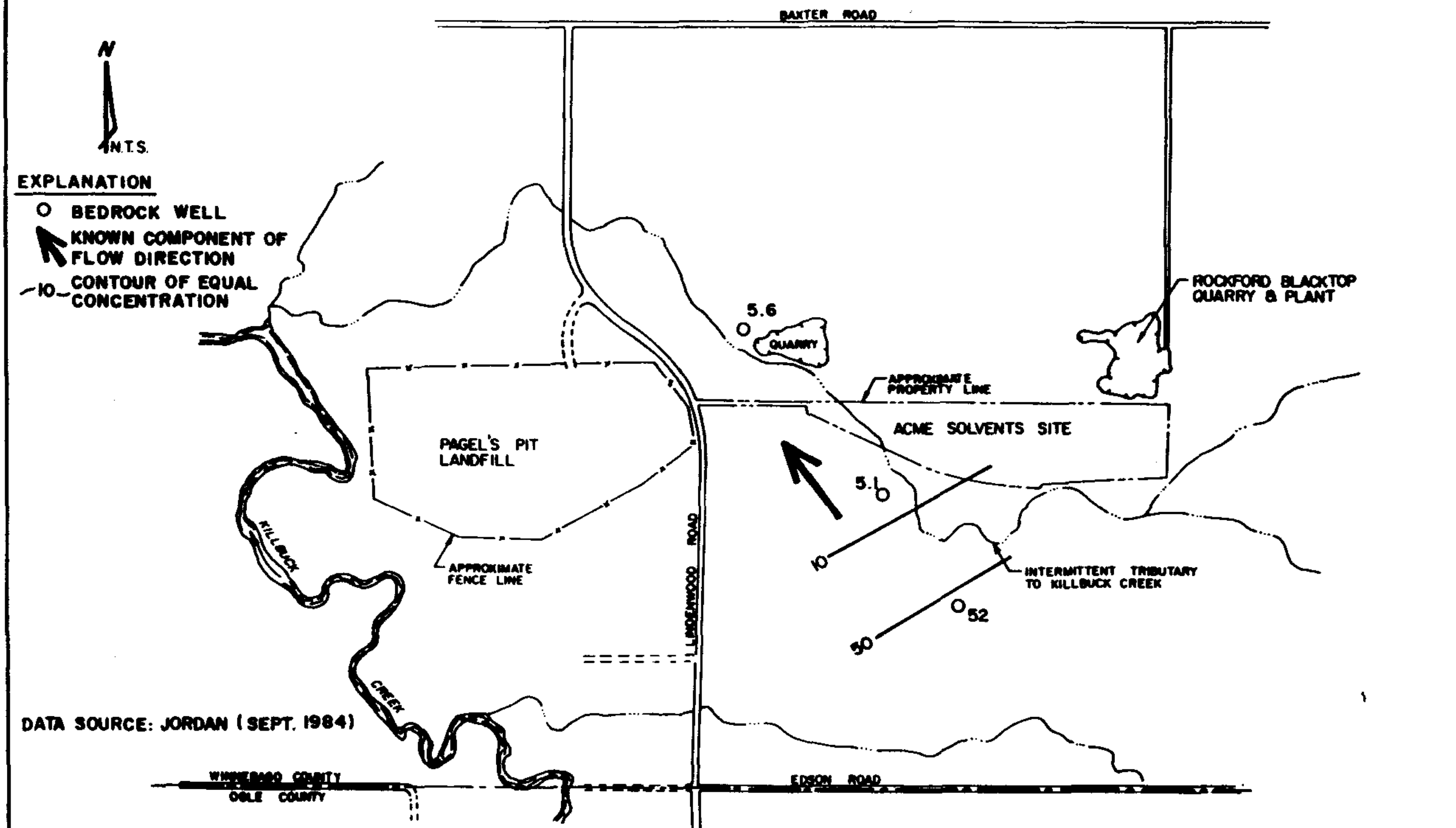
ACME SOLVENTS SUPERFUND SITE	E.A. HICKOK & ASSOCIATES	MAR. 1985
GROUNDWATER QUALITY IN CROSS-SECTION F-F'	HYDROLOGISTS - ENGINEERS MINNEAPOLIS - MINNESOTA	2.14



ACME SOLVENTS SUPERFUND SITE	E.A. HICKOK & ASSOCIATES HYDROLOGISTS - ENGINEERS MINNEAPOLIS - MINNESOTA	MAR. 1985
TOTAL VOLATILES (ug/l) IN SHALLOW WELLS		2.15



ACME SOLVENTS SUPERFUND SITE	E.A. HICKOK & ASSOCIATES HYDROLOGISTS-ENGINEERS MINNEAPOLIS-MINNESOTA	MAR. 1985
TOTAL VOLATILES (ug/l) IN INTERMEDIATE WELLS		2.16



ACME SOLVENTS SUPERFUND SITE

TOTAL VOLATILES (ug/l) IN DEEP WELLS

E.A. HICKOK & ASSOCIATES
HYDROLOGISTS-ENGINEERS
MINNEAPOLIS-MINNESOTA

MAR. 1985

2.17

Data for the three deep wells are shown in Figure 2.17. Also show is the known component of flow direction at such depths, which is toward the northwest (see section 4.1). (With additional deep wells, the overall flow direction could be found to be more northerly or more westerly.) Total volatiles are highest in the most southeasterly of the three wells.

The indication from Figure 2.17 is that the Acme site is not a source of deep contamination, but that such a source is located substantially to the south of the Acme site.

3.0 PERMEABILITY DETERMINATION

Permeability tests were conducted in two monitoring wells (MW-104 and MW-107) and two piezometers (P-8 and P-9) during the RI. All four wells and piezometers were 2-inch diameter casings and screens. The tests were all single-well tets; that is, the same well was used for both perturbing the aquifer flow system and measuring the response.

Considering especially the nature of the aquifer -- massive dolomite, generally described as "very vuggy and porous" (Jordan, Sept. 1984, Appendix B-2) -- the permeability tests performed in the RI should be viewed as giving only a crude indication of actual permeabilities. The permeability test methods in the RI, utilizing single, small-diameter wells, are "short-cut" methods.

Accurate permeability testing would entail, for each measurement location, multiple observation wells and continuous pumping over one or several days from a large-diameter well yielding sufficient flow to cause clearly measurable drawdown in the observation wells.

Alternatively, regional permeability data developed by the Illinois Geological Survey, if available, woudl be expected to be more reliable than the RI test results.

4.0 GROUNDWATER FLOW

Water level data obtained in the RI on various dates from March through early May 1984 have been reviewed toward defining horizontal and vertical flow patterns.

4.1 Horizontal Flow

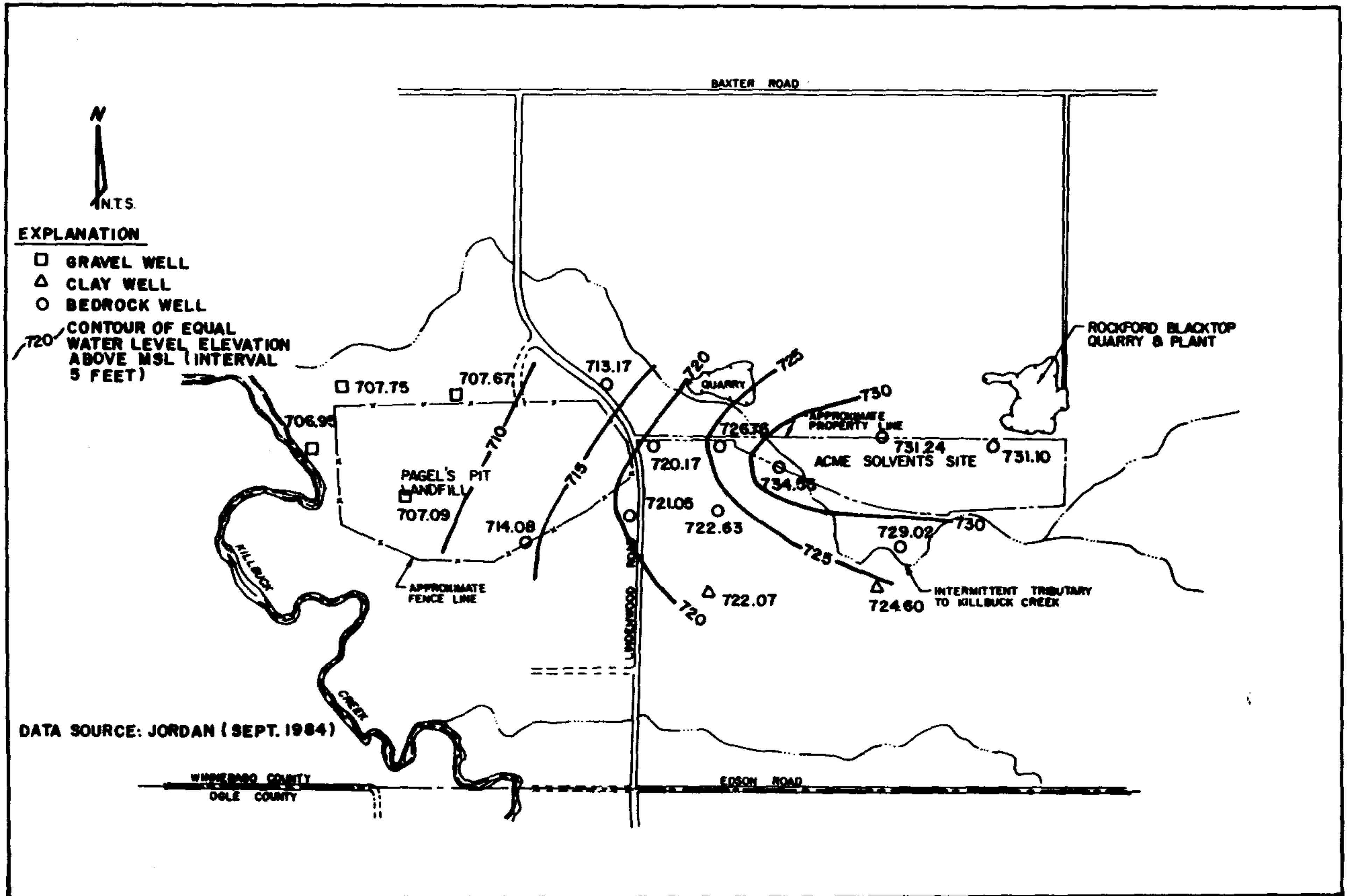
Figures 2.18 to 2.20 depict horizontal patterns of hydraulic head in aquifer strata corresponding to shallow, intermediate and deep wells, respectively. The data are for the latest date with extensive measurements in each stratum (May 4, 1984 for shallow and intermediate depths; April 26, 1984 for deep wells). Data for earlier dates were also plotted but are not presented here.

For the shallow wells (Figure 2.18), the horizontal pattern of head indicates generally west-northwesterly flow, but with radial components emanating from the Acme site vicinity. The pattern was similar from early March through early May, with minor variations.

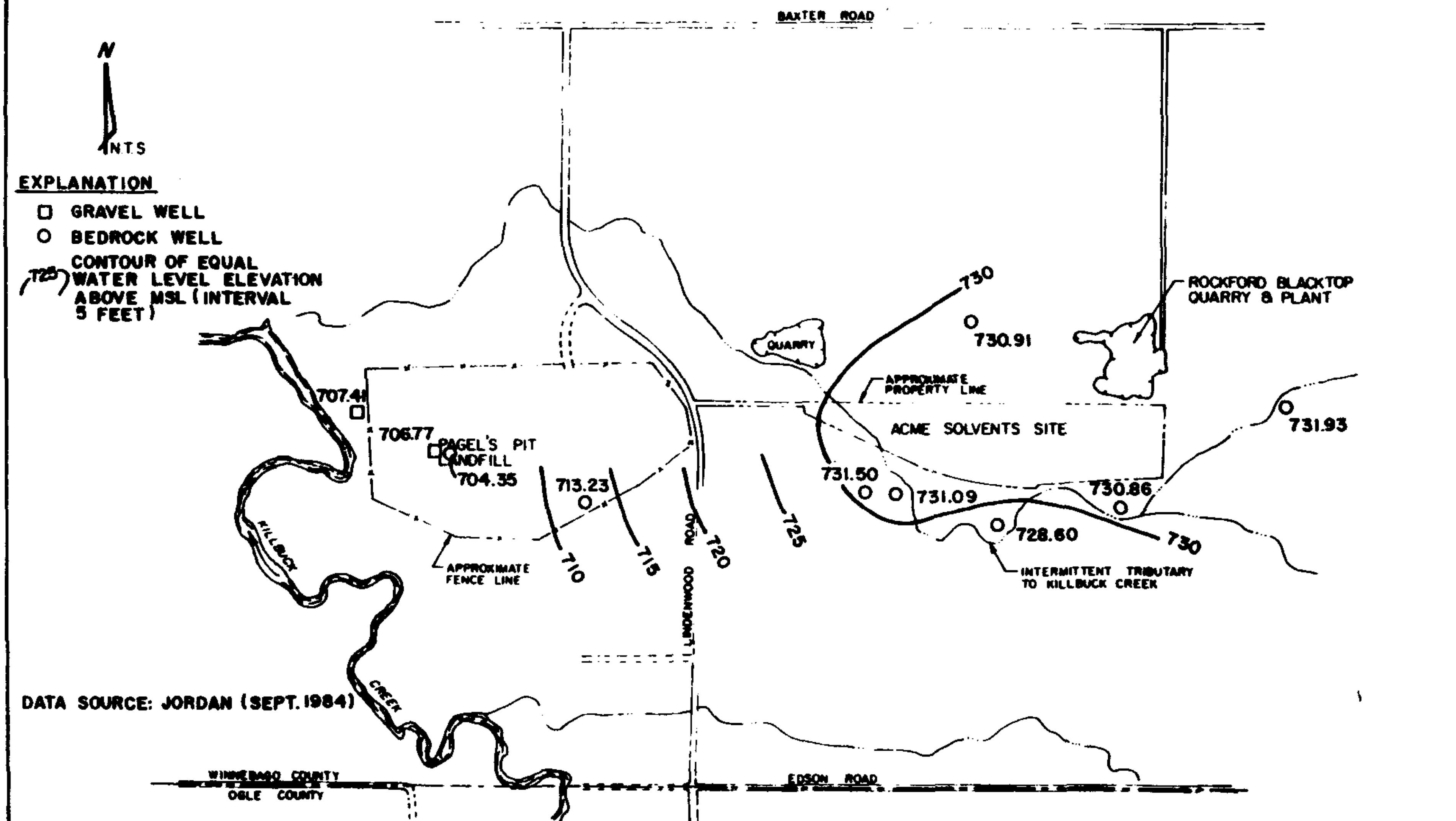
The implied flow pattern is in good agreement with E. C. Jordan's interpretation (see again Figure 2.5). However, Figure 2.18 depicts conditions only in the upper one-tenth of the shallow aquifer. Jordan's interpretation, on the other hand, seems implicitly to describe the entire shallow aquifer. The flow pattern is actually quite different at greater depths.

The contours of hydraulic head in Figure 2.18 represent the elevation of the water table. For wells at greater depths, however, water level (hydraulic head) measurements can differ from water table elevations; and such differences occur in the area of concern here.

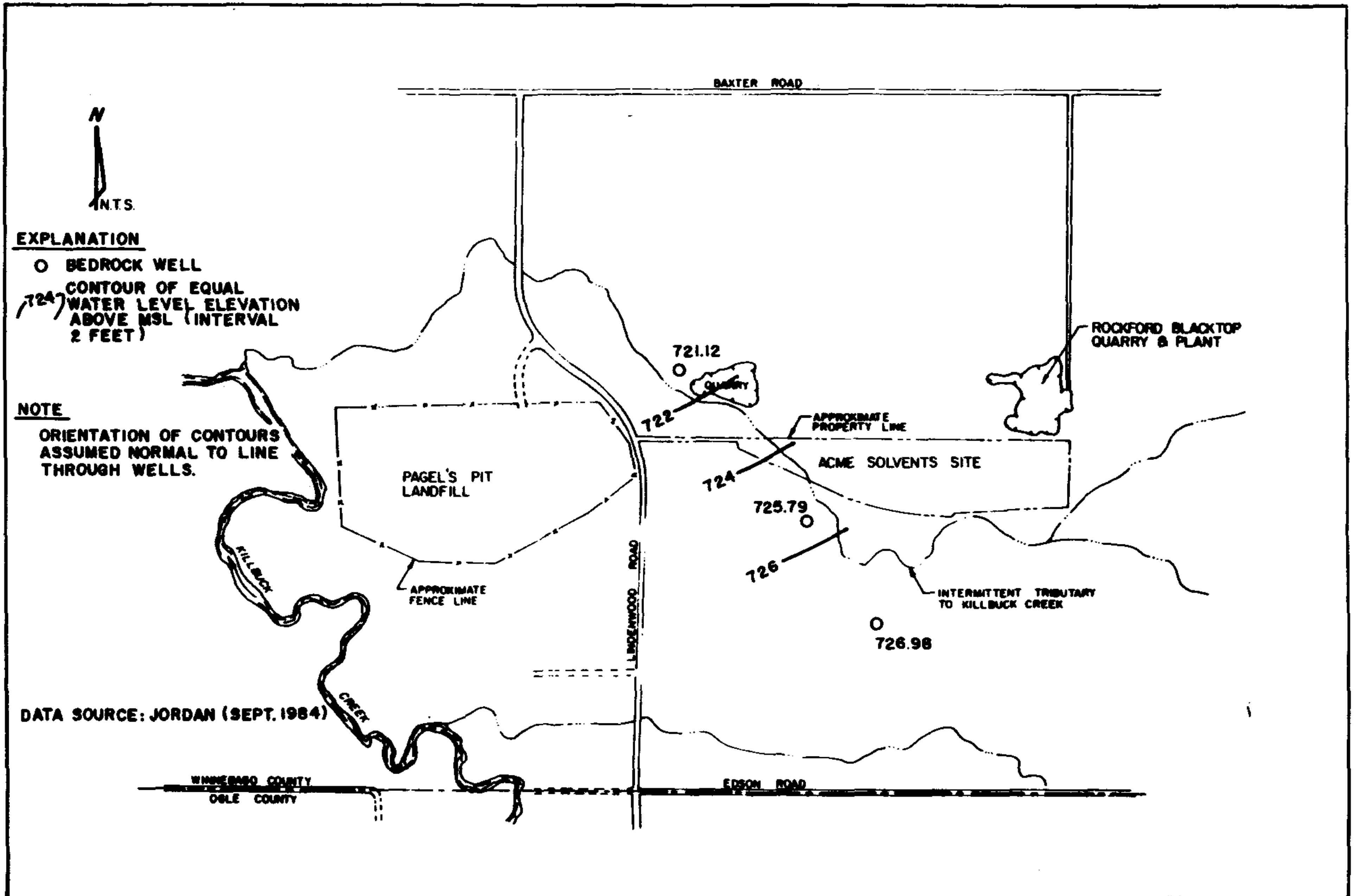
Figure 2.19, then, shows the horizontal pattern of hydraulic head based on wells of intermediate depth, and the pattern is somewhat different from that for the shallow wells. The general elements of westward flow combined with radial flow



ACME SOLVENTS SUPERFUND SITE	E.A. HICKOK & ASSOCIATES HYDROLOGISTS-ENGINEERS MINNEAPOLIS-MINNESOTA	MAR. 1985
SHALLOW WELL WATER LEVELS - MAY 4, 1984		2.18



ACME SOLVENTS SUPERFUND SITE	E.A. HICKOK & ASSOCIATES HYDROLOGISTS - ENGINEERS MINNEAPOLIS - MINNESOTA	MAR. 1985
INTERMEDIATE WELL WATER LEVELS - MAY 4, 1984		2.19



ACME SOLVENTS SUPERFUND SITE

DEEP WELL WATER LEVELS - APRIL 26, 1984

E.A. HICKOK & ASSOCIATES
HYDROLOGISTS - ENGINEERS
MINNEAPOLIS - MINNESOTA

MAR. 1985

2.20

from the Acme site vicinity are present, but the westward flow has a southerly component, rather than a northerly one. Intermediate-depth data from march and April also indicate a southerly flow component.

The generally westward hydraulic gradient in the shallow and intermediate strata is of the order of 0.01 feet per foot.

From Figure 2.20, the horizontal flow pattern in the deep stratum appears to be radically different from the pattern at shallower depths (Note again that the "deep" wells in the RI penetrated only the upper half of the shallow aquifer. The terms "deep stratum" and "deep wells" are used relatively in this memorandum.) With only three deep wells, and with the wells in a linear configuration, it is possible only to determine one component of gradient and flow.

In Figure 2.20 the known component of gradient is northwestward and is on the order of 0.003 feet per foot. Deep-well data from March and earlier in April give the same results. There is a corresponding northwestward flow component. However, additional deep wells could reveal an overall gradient (and flow direction) that is either more northerly or more westerly than that shown in Figure 2.20. A westward flow direction would be easier to reconcile with the shallow data.

In any case, the "deep" horizontal flow pattern cannot be fully determined without water level data from additional deep wells.

4.2 Vertical Flow

4.2.1 Vertical Gradients

Four locations have well nests consisting of two or three wells and/or piezometers. The locations are:

- Near Killbuck Creek (P-1, MW-106)
- Pagel's Pit (P-3, P-4, P-5)
- Southwest of the Acme Site (B-6S, B-6D, MW-105)
- South of the Acme Site (P-8, P-9)

Available water level measurements were analyzed at these locations to determine the magnitude of vertical hydraulic head gradients. The measurements are from the RI and extend from March 24 through May 4, 1984. Table 2.6 summarizes the results. The gradients are given as positive-upward, negative-downward.

Near Killbuck Creek the gradients were upward -- indicating groundwaer discharge to the creek -- except between April 26 and May 1. During that period it appears that the creek's stage was sufficiently high to cause groundwater recharge from the creek, rather than discharge to the creek.

In Pagel's Pit the gradients were upward throughout the monitored depth on April 30 and downward throughout on May 4. The downward gradient on May 4 plausibly reflects recharge from infiltrating water. The data earlier in April, however, are peculiar. Upward gradients (hence flows) are indicated at shallower depths, downward ones at greate depths. The upward shallower flow may be a reflection of discharge to nearby Killbuck Creek, while the downward deeper flow may indicate leakage to deeper strata.

Data for the well nest southwest of the Acme site is difficult to interpret because of long, overlapping sand-pack intervals. From Table 2.1, the sand packs for the three wells here extend over the following elevations:

Well	Sand Pack Elevation (ft)
B-6S	700 - 717
B-6D	652 - 712
MW-105	675 - 687

TABLE 2.6

SUMMARY OF VERTICAL GRADIENT DATA

ACME SOLVENTS DISPOSAL SITE

Location			Vertical Groundwater Gradient on Date								
	Vertical Range*										
Geographic	Elevation (ft)	Depth Below W.L. (ft)	3/24/84	3/28/84	4/19/84	4/26/84	4/28/84	4/30/84	5/1/84	5/3/84	5/4/84
Near Killbuck Creek (P-1, MW-106)	665-697	10-42	+.009	+.005	+.005	0	--	--	-.01	--	+.02
Pagel's Pit (P-3, P-4, P-5)	682-710	0-24	--	--	+.2	+.004	--	+.004	--	--	-.01
	661-688	18-45	--	--	-.1	-.001	--	+.001	--	--	-.1
	661-710	0-45	--	--	+.05	+.001	--	+.003	--	--	-.07
SW of Acme** (B-6S, B-6D, MW-105)	675-717	13-55	+.003	+.04	+.007	+.003	+.007	--	--	0	-.01
	652-687	43-78	-.2/-.4	-.2/-.5	-.2/-.4	-.2/-.4	-.2/-.4	--	--	-.2/-.5	-.2/-.5
	652-717	13-78	-.09/-.1	-.08/-.1	-.07/-.1	-.09/-.1	-.09/-.1	--	--	-.09/-.1	-.1/-.1
S of Acme (P-8, P-9)	695-716	12-33	+.005	+.01	+.2	-.008	-.008	--	--	--	-.03

*Vertical ranges include entire elevation range of sand pack zones for wells and/or piezometers used in the gradient determinations. Depth below water level (W.L.) based on typical water level in shallowest well or piezometer in each nest.

**Elevation range 675-717 ft based on wells B-6S and MW-105; range 652-687 ft on MW-105 and B-6D; range 652-717 ft on B-6S and B-6D. In the latter two cases, well B-6D was assumed to represent water levels for aquifer elevations 655 or 670 ft, yielding ranges in gradient.

The sand pack of well B-6D fully overlaps that of well MW-105 and overlaps most of the sand pack of B-6S.

The mid-points of the sand packs of wells B-6D and MW-105 are practially identical: 682 and 681 feet, respectively. However, during March-May 1984, well B-6D always exhibited downward gradients with respect to B-6S, while MW-105 exhibited upward gradients, except for the last few days of observations. These are directly contradictory results. And again, the main obstacle to data interpretation here is the long sand pack of well B-6D.

A plausible reconciliation of the above facts is gotten by supposing that water levels measured in well B-6D represent aquifer conditions at some elevation below well MW-105's sand pack. This elevation would necessarily be within the range of 652 to 675 feet. For purposes of analysis, the elevations 655 and 670 were selected; the computed vertical gradients then are presented as a range corresponding to these two choices.

The data in Table 2.6 for the location southwest of the Acme site were developed on the above basis. The results then show upward gradients at shallower depths (except in May), and downward gradients at greater depths. The magnitudes of the latter are on the order of -0.2 to -0.5 feet per foot (downward). Lumping the shallower and deeper data together, the overall vertical gradients are on the order of -0.1 feet per foot (downward).

The piezometer nest south of the Acme site showed upward gradients in March-early April and downward gradients thereafter.

Substantial seaonsal variations in vertical gradients and flow can be expected in light of the above variability over the March-May 1984 period.

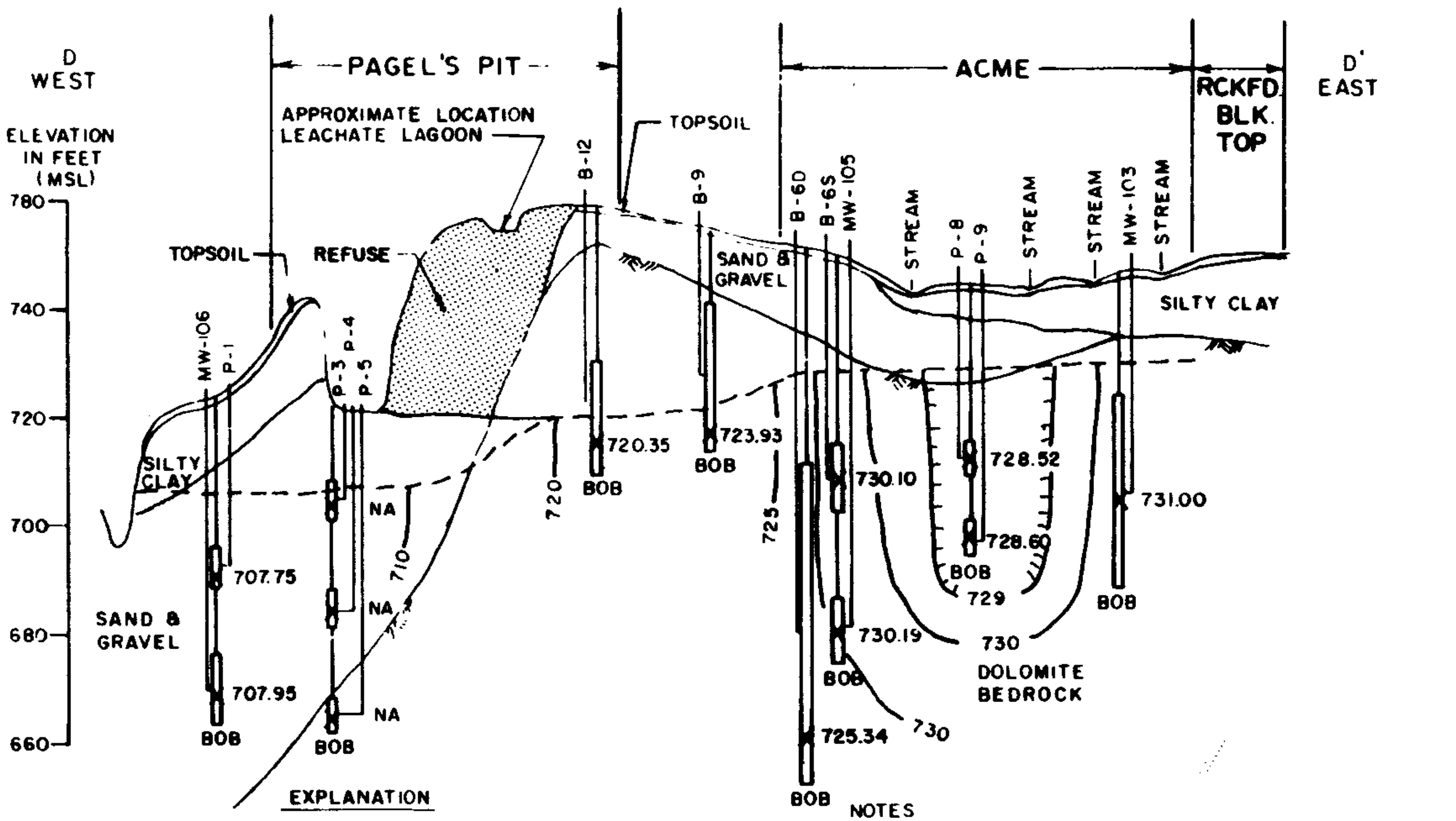
4.2.2 Flow in Vertical Cross-Section

Figures 21 to 23 display vertical cross-sectional views of hydraulic head on March 24, April 19, and May 4, 1984. For this purpose, the east-west cross-section D-D' was selected as most informative (see again Figure 2.8 for location).

A peculiar aspect of these figures is the convergence of flow in the vicinity of piezometers P-8 and P-9, as indicated by lower water levels there than in all surrounding wells in the cross-section. The situation looks especially odd in March and April (Figures 2.21 and 2.22), when an upward gradient also existed between P-8 and P-9. Where did the flow go? A perpendicular (north-south) view of data including P-8 and P-9 reveals that the flow was southward there -- i.e., out of the page in Figures 2.21 and 2.22.

The figures also show a persistent divergence of flow from the vicinty of wells B-6S and MW-104: flow from there always went both eastward, toward P-8 and P-9, and westward, toward well B-9. The eastward flow had an upward component in March-April, but a downward component in May.

The May conditions are generally consistent with E. C. Jordan's interpretation of vertical groundwater flow, as depicted in Figure 2.7, for the Acme site vicinity. However, near Pagel's Pit and Killbuck Creek, the interpretation in Figure 2.7 corresponds to March-April conditions, rather than those in May.



EXPLANATION

SCREENED INTERVAL (SLOTTED SECTION AND SAND-PACKED ZONE)

BOB-BOTTOM OF BORING

X-ASSUMED LOCATION OF MEASUREMENT

—725— CONTOUR OF EQUAL WATER LEVEL ELEVATION ABOVE MSL (INTERVAL IRREGULAR)

APPROX HORIZONTAL SCALE
0 500 1000 FEET

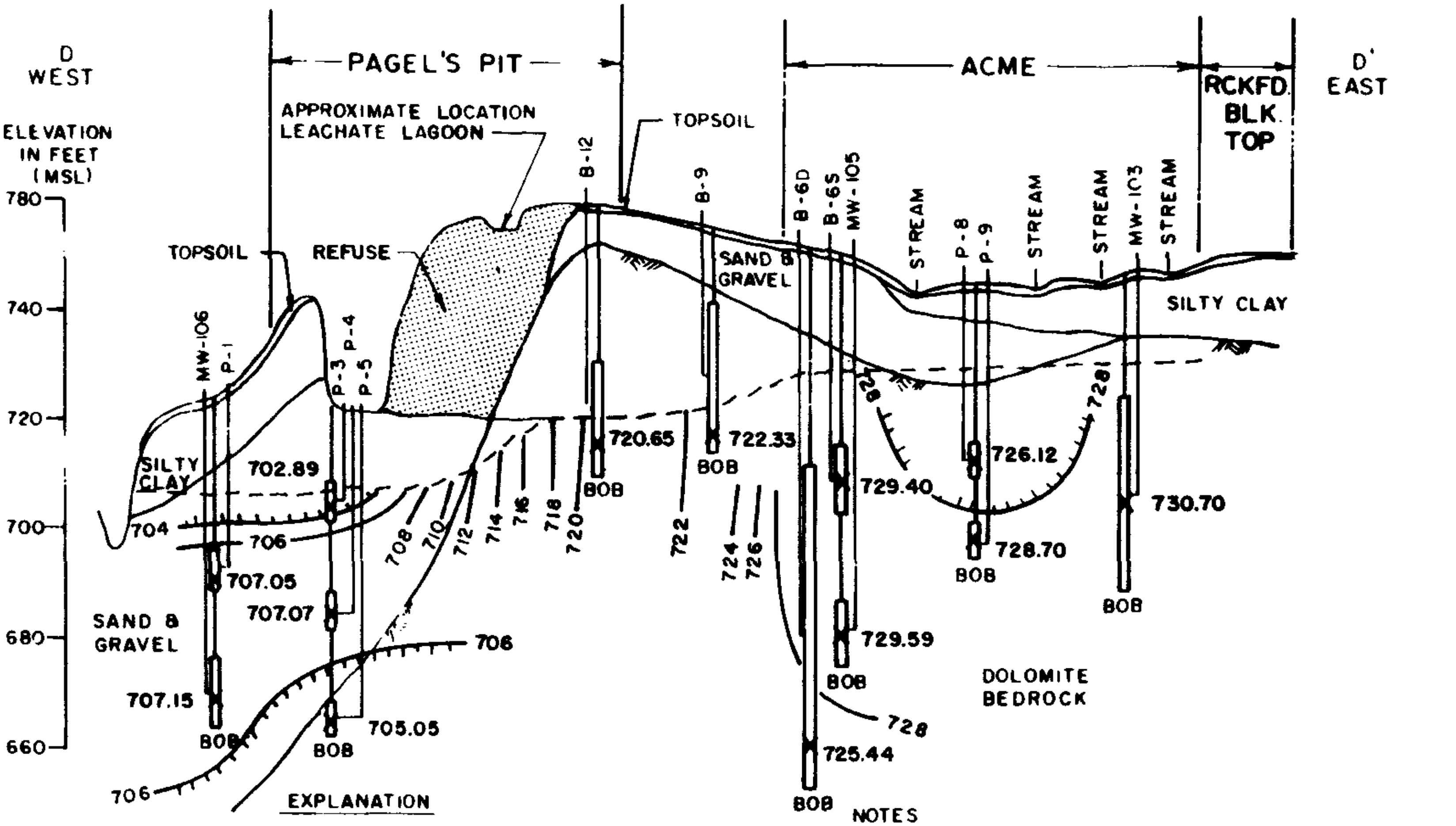
NOTES

1 REDRAWN AFTER JORDAN (SEPT. 1984), EXCEPT FOR THE ADDITION OF WATER LEVEL DATA AND CONTOURS, AND APPROXIMATE LOCATIONS OF PAGEL'S PIT, ACME SITE, AND ROCKFORD BLACKTOP.

2 GROUND LINES SHOWN ARE APPROXIMATE.

DATA SOURCE: JORDAN (SEPT. 1984)

ACME SOLVENTS SUPERFUND SITE	E.A. HICKOK & ASSOCIATES HYDROLOGISTS-ENGINEERS MINNEAPOLIS-MINNESOTA	MAR.1985
WATER LEVELS IN CROSS-SECTION D-D' MARCH 24,1984		2.21



EXPLANATION

SCREENED INTERVAL (SLOTTED SECTION AND SAND-PACKED ZONE)

BOB-BOTTOM OF BORING

X-ASSUMED LOCATION OF MEASUREMENT

—722— CONTOUR OF EQUAL WATER LEVEL ELEVATION ABOVE MSL (INTERVAL 2 FEET)

APPROX HORIZONTAL SCALE

0 500 1000 FEET

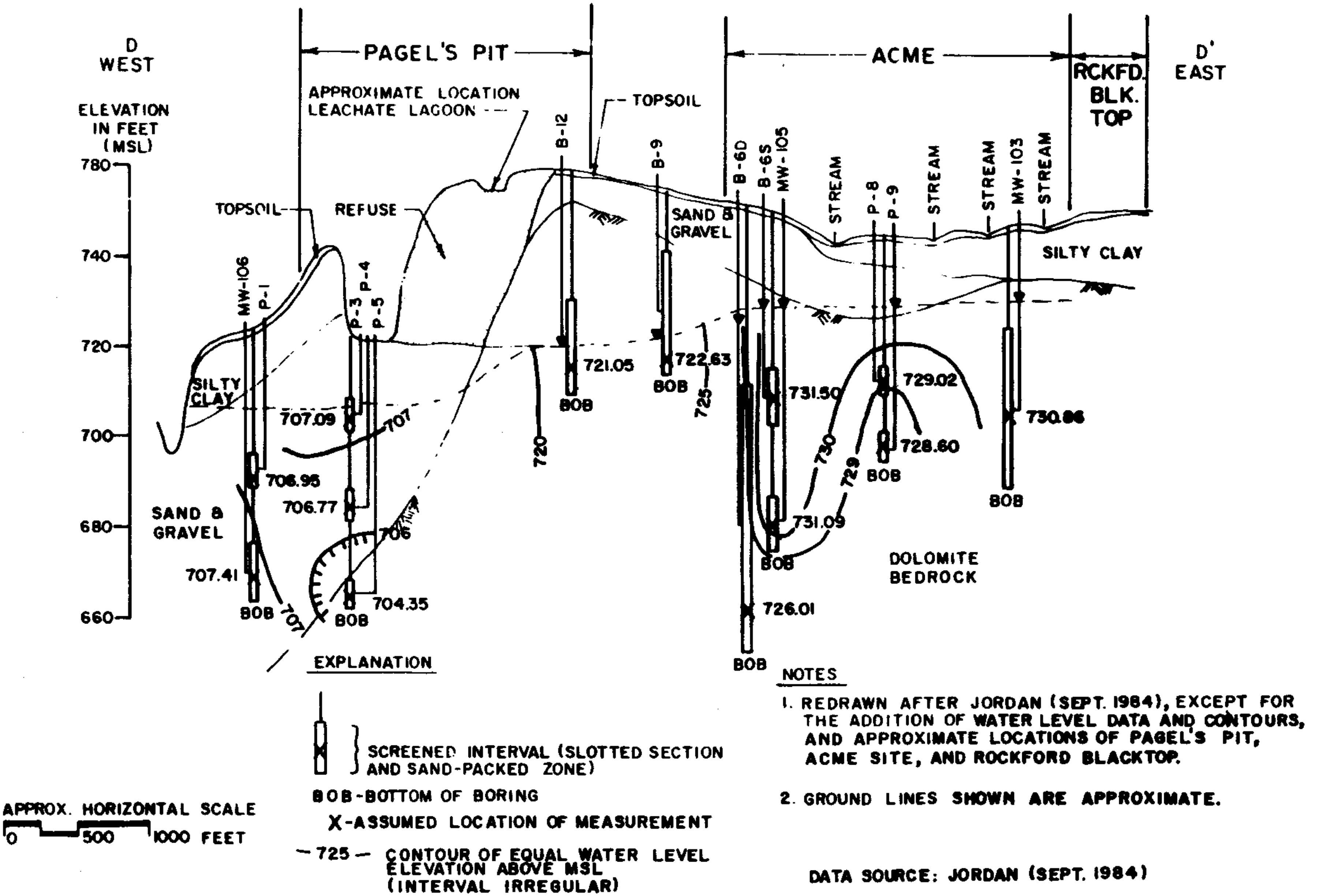
NOTES

1 REDRAWN AFTER JORDAN (SEPT. 1984), EXCEPT FOR THE ADDITION OF WATER LEVEL DATA AND CONTOURS, AND APPROXIMATE LOCATIONS OF PAGEL'S PIT, ACME SITE, AND ROCKFORD BLACKTOP.

2 GROUND LINES SHOWN ARE APPROXIMATE.

DATA SOURCE: JORDAN (SEPT. 1984)

ACME SOLVENTS SUPERFUND SITE	E.A. HICKOK & ASSOCIATES HYDROLOGISTS-ENGINEERS MINNEAPOLIS-MINNESOTA	MAR. 1985
WATER LEVELS IN CROSS-SECTION D-D' APRIL 19, 1984		2.22



NOTES

1. REDRAWN AFTER JORDAN (SEPT. 1984), EXCEPT FOR THE ADDITION OF WATER LEVEL DATA AND CONTOURS, AND APPROXIMATE LOCATIONS OF PAGEL'S PIT, ACME SITE, AND ROCKFORD BLACKTOP.
2. GROUND LINES SHOWN ARE APPROXIMATE.

DATA SOURCE: JORDAN (SEPT. 1984)

ACME SOLVENTS SUPERFUND SITE	E.A. HICKOK & ASSOCIATES HYDROLOGISTS-ENGINEERS MINNEAPOLIS-MINNESOTA	MAR. 1985
WATER LEVELS IN CROSS-SECTION D-D' MAY 4, 1984		2.23

5.0 OTHER SITES' INFLUENCE ON ACME SITE

From the preceding discussion it is apparent that the Pagel's Pit landfill does not influence conditions at the Acme site because of the groundwater flow pattern. However, there is evidence for one or more contaminant sources upgradient (eastward) froma the Acme site that influence conditions on the site. In particular, the pattern of total volatiles concentration at intermediate depths indicates some upgradient source. The Rockford Blacktop plant is a likely source, but none of the monitoring wells installed to date is located so as to observe impacts from this plant directly. The attribution of specific sources in the upgradient area would require additional monitoring wells there.

6.0 CONTAMINATION EFFECTS ON SURFACE WATERS

The potential route for surface water contamiantion from the Acme site is via overland runoff to the intermittent tributary to Killbuck Creek that runs near the southern boundary of the site. Monitoring in the RI revealed no detectable organic contaminants, however, in the tributary or its sediments. An alternative route would be via groundwater flow discharging to Killbuck Creek, but contaminants originating from the Acme site had traveled only a fraction of the distance to Killbuck Creek as of 1984.

Thus there are no contamination effects from the Acme site on surface waters.

7.0 CONCLUSIONS

This review has led to the following conclusions regarding the remedial investigation for the Acme site.

1. Many monitoring wells used in the RI have long sand-pack intervals (up to 78 feet), resulting in ambiguous data and probably contributing to the vertical spread of contaminants in the groundwater.

2. The possibility cannot be ruled out that certain monitoring wells may have been contaminated by water used in their drilling, as no analyses of the water are reported. Included here are well B-6D, installed in the FIT investigation, and all 15 of the wells and piezometers installed in the RI.

3. Monitoring wells and piezometers installed in the RI could have been cross-contaminated, since there is no documentation of decontamination procedures between wells.

4. Drilling mud with significant concentrations of toxic metals, particularly lead, was ued in the construction of monitoring wells and piezometers in the RI.

5. The drilling subcontractor used in the RI is not a licensed well driller in the State of Illinois (licensing there is specifically for drilling public water supply wells or other wells serving more than one home; however, licensing could bear indirectly on the quality of monitoring well installation).

6. Any statement about contamination of deeper aquifers would be highly speculative, since only the upper half of the shallow aquifer is penetrated by monitoring wells of known depth used in the RI. Moreover, all but three of the wells and piezometers are in the upper two-tenths of the aquifer's saturated thickness.

7. At depths corresponding to the three "deep" wells noted above, the horizontal patterns of groundwater flow and contamination are incompletely known -- not only because of the small number of wells, but also because the three wells are virtually on a straight line (trending northwest-southeast).

8. The Acme site does not appear to be the source of volatile organics contamiantion at the depths of the "deep" wells. In fact, the indication from the data is that "deep" contamination originates from a location to the south or southeast of the Acme site.

9. Of the wells at intermediate depths (between one- and two-tenths of the aquifer's thickness), six wells extending through the Pagel's Pit area and to the southeast give incomplete groundwater flow and contamination data because they lie virtually on a straight line.

10. In the Acme site vicinity, volatile organics were not detectable in wells at intermediate depths, except near the extreme eastern (upgradient) end of the site. Moreover, the horizontal pattern of volatile organics contamination at intermediate depths indicates a source of contaminants clearly upgradient from the Acme site.

11. There is absolutely no basis in the RI data for ruling out the Rockford Blacktop plant and quarry as a source of groundwater contamination, because none of the monitoring wells or piezometers used in the RI are located definitely in the path of groundwater flow from that site.

12. the Rockford Blacktop plant and quarry is a likely source of organic groundwater contaminants based on: the chemical nature of materials used there; the large area of exposed bedrock, implying high infiltration; the indicated existence of at leas tone contaminant source upgradient from the

Acme site; and volatile organics contamiantion in two wells near the edge of the likely flow path emanating from the Rockford Blacktop site.

13. Additional upgradient wells would be required to resolve uncertainties regarding contaminant sources there.

14. The RI permeability tests in the Galena dolomite are of limited usefulness, being single-well tests using small-diameter (2-inch) wells and piezometers. In a massive dolomite aquifer, accurate permeability measurements would involve, at each location, multiple observation wells with a large-diameter pumping well and substantial pumping rates over a period fo one or more days.

15. Horizontal groundwate flow in the upper one-tenth of the shallow aquifer generally acocrds with the interpretation in the RI (Jordan, Sept. 1984, Figure 2.21; redrawn as Figure 2.5 in this memorandum).

16. Horizontal flow patterns in deeper portions of the aquifer do not accord with the interpretation in the RI, especially at the depths of the "deep" wells, where the known component of flow is toward the northwest.

17. It is not posisble to interpret definitively the vertical groundwater gradients at the well nest southwest of the Acme site (wells B-6S, B-6D and MW-105), because of long, overlapping sand pack intervals.

18. The interpretation in the RI of east-west vertical groundwater flow (Ibid, Figure 22; redrawn as Figure 2.7 in this memorandum) depends crucially on the interpretation of vertical gradients at the above well nest.

19. Water level monitoring through at least one annual cycle and at additional discrete-depth wells int he Acme site area would be required to resolve uncertainties regarding vertical groundwater flow pattern there.

20. Pagel's Pit is clearly a source of groundwater contamination but does not affect groundwater quality in the immediate vicinity of the Acme site.

21. Water and sediment samples from the intermittent tributary to Killbuck Creek, near the southern boundary of the Acme site, revealed no indication of impacts from the Acme site (Ibid, page 66).

8.0 REFERENCES

Ecology and Environment, Inc. (March 1983), "Extent of Sources of Groundwater Contamination -- Acme Solvents/Pagel's Pit Area Near Morristown, Illinois." FIT project task report to U.S. EPA.

Jordan, E. C. and Co. (Sept. 1984), "Acme Solvents Superfund Site, Winnebago County, Illinois -- Remedial Investigation." Prepared for Illinois EPA, 2 volumes.

Mathes, John and Associates (Feb. 27, 1985), personal telephone communication with John Lichter of E. A. Hickok and Associates.

PART THREE

EVALUATION OF POTENTIAL REMEDIAL ACTION AT THE ACME SOLVENTS SUPERFUND SITE

1.0 INTRODUCTION AND PURPOSE

The section examines proposed remedial actions developed by the Illinois Environmental Protection Agency's (IEPA) contractor, E.C. Jordan Co. (Jordan). Based on this examination, it appears that several conclusions reached in the RI/FS work are suspect and require further confirmation prior to the implementation of any remedial action (see references 10 and 11).

2.0 REMEDIAL ACTIONS EVALUATION

The Feasibility Study (FS) evaluated several remedial action alternatives for remediation at the ACME site. These alternatives were divided into several areas which included on-site and off-site remedial techniques. These techniques were combined into various alternatives for comparisons. Each technique was further grouped into avoidance, containment, removal and treatment technologies. Tables 3.1, 3.2A, and 3.2B are compiled from information and cost estimates presented in the feasibility study.(2)

The effectiveness score in Tables 3.2A and 3.2B is a subjective ranking system employed to factor non economic considerations into the alternative selection process. Tables 19 and 20 of the FS summarize the effectiveness criteria. This subjective ranking score played a considerable role in the selection of on-site alternative 6a and off-site alternative 5a in the FS report. The National Contingency Plan for Hazardous Substance Response outlines a method to screen remedial action alternatives 40 CFR 300.68(h). The major screening factors for consideration are cost, environmental and health effects and acceptable engineering practices. Section (j) of Part 300.68 further states:

> "(j) The appropriate extent of remedy shall be determined by the lead agency's selection of the remedial alternative which the agency determines is cost-effective (i.e. the lowest cost alternative that is technologically feasible and reliable and which effectively mitigates and minimizes damage to and provides adequate protection of public health, welfare, or the environment)."

2.1 RESPONSE OBJECTIVES

These effectiveness scores were developed to evaluate response objectives formulated by Jordan and IEPA. The objectives are:(2)

(1) Provide drinking water of acceptable quality in the surficial aquifer at the site boundary.

TABLE 3.1

CAPITAL AND OPERATING COST ESTIMATES FOR REVIEWED TECHNOLOGIES

Category	General Technology Reading	Specific Technology	Feasibility Status	Capital Cost	Annual Operating Cost
Avoidance					
	Receptor Relocation	--	Not Justified		
	Development of Individual Water Supplies	Home Water Treatment Units	Feasible	$2,000 each Total $32,000	$920 each Total $14,720
	Development of Community Water Supplies				
		Development of New Well	Feasible	$380,000	More Information Needed
		Obtain Rights to Existing Well	Not Feasible	Not Priced	
	Extension of Existing Water Supply				
		Rockford	Not Feasible	$1.2 million	More Information Needed
		Stillman Valley	Not Feasible	$1.4-$2.7 million	More Information Needed
		Morristown Trailer Park	Not Feasible	$530,000	More Information Needed
	Site Fencing		Feasible	$90,500	More Information Needed
Containment					
	Site Capping		Feasible	$930,000	$14,000+
	In-place Vitrification		Not Feasible	Not Priced	
	Solidification/Fixation		Feasible with Restrictions		$80-$120/ton
	Storage		Not Feasible	Not Priced	
	Collection Drains		Feasible with Restrictions	Not Priced	
	Barrier Walls		Not Feasible	Not Priced	
	High Pressure Grouting		Feasible	$1.8 million	
	RCRA Approved Facility		Feasible	$639,000	

TABLE 3.1 (continued)

CAPITAL AND OPERATING COST ESTIMATES FOR REVIEWED TECHNOLOGIES

Category	General Technology Reading	Specific Technology	Feasibility Status	Capital Cost	Annual Operating Cost
Removal					
	Excavation and Trucking		Feasible	$1.5 million	
	Land Farming		Not Feasible	Not Priced	
	Flushing (Leaching)		Not Feasible	Not Priced	
Treatment					
	Air-Stripping	Packed Tower	Feasible	$150,000-$200,000	$5,000
	Activated Carbon	Packed Column	Feasible	$1 million	More Information Needed
	Reverse Osmosis		Not Feasible	Not Priced	
	Oxidation		Not Feasible	Not Available	
	In-Situ Biodegradation		Not Feasible	Not Priced	
	Off-Site Land Disposal		Feasible	$4 million	
	Incineration	On-Site	Feasible	$5-$20 million	
		Off-Site	Feasible	$28 million	
	Pyrolysis		Not Feasible	Not Priced	

TABLE 3.2A

SUMMARY OF EFFECTIVENESS SCORE AND TOTAL COST
ON-SITE ALTERNATIVES

Alternative Number	Alternative Description	Effectiveness Score	Total Capital Cost	Total Operating Cost	Total Cost
1	No action.	34	$ 92,000	$ 228,000	$ 350,000
2	Site capping and monitoring.	49	1,352,000	1,446,000	2,798,000
3a	Excavation, off-site land disposal (RCRA facility) and bedrock grouting.	74	9,966,000	116,000	10,082,000
4a	Excavation, off-site incineration and bedrock grouting.	78	34,800,000	116,000	34,916,000
5a	Excavation, on-site landfill (RCRA facility) and bedrock grouting.	49	3,549,000	3,668,000	7,217,000
6a	Excavation, on-site incineration, bedrock grouting	66.5	10,519,000[2]	116,000	10,635,000
6b	Excavation, on-site incineration, on-site ash disposal (RCRA facility) and bedrock grouting.	64	11,278,000[2]	1,418,000	12,696,000
7a	Excavation, on-site land disposal of soils (RCRA facility), off-site land disposal of drums (RCRA facility), and bedrock grouting.	53	4,651,000	3,668,000	8,319,000
8a	Excavation, on-site incineration of soils, off-site land disposal of drums (RCRA facility), and bedrock grouting.	64	11,565,000[2]	116,000	11,681,000
8f	Excavation, on-site incineration of soils, off-site land disposal of drums (RCRA facility), on-site ash disposal (RCRA facility), and bedrock grouting.	63.5	12,334,000	1,418,000	13,752,000

(1) All information taken from Ref. #2.
(2) Infrared furnace alternative costs. All costs rounded to the nearest $10,000.

TABLE 3.2B(1)

SUMMARY OF EFFECTIVENESS SCORE AND TOTAL COST
OFF-SITE ALTERNATIVES

Alternative Number	Alternative Description	Effectiveness Score	Total Capital Cost	Total Operating Cost	Total Cost
2	Installation of home treatment units (16 homes).	66	$ 42,000	$ 726,000	$ 768,000
3	Development of an upgradient well and new community water supply.	61	360,000	344,000	704,000
4a, 4b	Groundwater extraction and treatment	66.5			
	a) No treatment required.		771,000	652,000	1,423,000
	b) Treatment with activated carbon (4a).		2,141,000	1,203,000	3,344,000
	c) Treatment with air-stripping (4b).		883,000	745,000	1,628,000
5a	Groundwater extraction, treatment and installation of home water treatment units.	78			
	a) No treatment required.		813,000	764,000	1,577,000
	b) Treatment with activated carbon.		2,183,000	1,315,000	3,498,000
	c) Treatment with air-stripping.		926,000	857,000	1,783,000
5b	Groundwater extraction, treatment and development of upgradient well and new community water supply.	78			
	a) No treatment required.		1,131,000	694,000	1,825,000
	b) Treatment with activated carbon.		2,501,000	1,245,000	3,746,000
	c) Treatment with air-stripping.		1,244,000	787,000	2,031,000

(1) All information taken from Ref. #2. All costs rounded to the nearest $1,000. Groundwater extraction costs for 1 mgd system.

(2) Ensure that adequate drinking water supplies will be maintained at the currently affected homes along Lindenwood and Edson Roads and other nearby residences not currently affected by the contaminant plume.

(3) Prevent further degradation of the deeper aquifers in the area, chiefly the St. Peter sandstone and the Eau Claire formation.

(4) Maintain the surface water quality in Killbuck Creek at levels designated by the State of Illinois.

(5) Eliminate surface contact hazards associated with surface and subsurface soils for current receptors and possible future on-site receptors.

(6) Maintain ambient air quality for on-site and off-site receptors.

(7) Minimize, to the extent technically and economically feasible, land disposal of wastes and limit all land disposal to within the State of Illinois.

Discussion:

The FS states the response objectives stated are based "on past waste disposal practices, exposure pathways, waste characteristics and potential receptors."[2] Objective three states that prevention of further contamination of deep aquifers is necessary. This implies these aquifers are now degraded and is not supported by data collected to date. Response item six implies that no air quality degradation is desirable and likely discourages remedial treatment methods which may increase ambient levels but remain at or below safe levels for potential receptors. Response item seven included at the request of IEPA is not based on any of the stated factors in the FS text. In fact it essentially negates a series of remedial alternatives which exist and are appropriately regulated under RCRA by EPA and IEPA. Furthermore, 40 CFR Part 300.68(2)(b), of the National Contingency Plan discusses appropriate criteria for hazardous substance remedial actions. Minimizing land disposal and out of state disposal are not mentioned. Response objective seven seems inappropriate since the RI/FS is to conform with the National Contingency Plan.

2.2 CRITERIA FOR RESPONSE OBJECTIVES

Based on these response objectives several criteria were developed. In summary these criteria are:

Objective No. 1-3: Provide acceptable drinking water quality. Drinking water standards are available and were used to establish concentrations of inorganic constituents. In general organic constituent standards have not been developed. The FS suggests the application of Preliminary Protective Concentration Limits (PPCL) to be the criteria applied. These PPLC's are in draft form and have not been adopted by EPA. The FS notes in some cases more stringent local criteria may be required. In cases where no PPLC or local level is established state criteria of 50 ppb for any priority pollutant is recommended.

Discussion:

Jordan notes in the FS that EPA could establish alternative concentration limits (ACL) for the ACME site. A series of ACL development criteria are presented but Jordan apparently concludes that ACL's are not justified at the ACME site in excess of the draft PPLC's or other criteria. This conclusion is not documented and Jordan states that "there is no firmly established basis for the 50 ppb standards" for priority pollutants without draft PPLC criteria.

Objective No. 4:

Maintain ambient surface water quality in Killbuck Creek.

Discussion:

The FS notes that no remedial action is necessary to improve existing surface water quality.

Objective No. 5:

Eliminate surface soil hazards. The FS notes that soil content criteria for many compounds does not exist. Work from California is used to develop criteria for inorganic metals and PCB. In addition discussion on Illinois and EPA PCB soil limits is presented (10 ppm and 50 ppm respectively). Illinois has a 1 ppm criterion for cyanide levels in soils. The FS notes soil background values for chemical constituents would be low to nil and would be overly conservative. For volatile and semi-volatile organic chemicals Jordan recommends a range of 10-805 mg/kg based on skin and eye tissue irritation.

Discussion:

Table 9 in the FS presents a summary of available response criteria. The background value for lead in Illinois soil is presented as 200 mg/kg but the level proposed for lead using the recommended California criteria is 100 mg/kg. Clearly the California criterion is not applicable in this case and may not be appropriate in others. U.S. EPA has set a criterion of 50 ppm for PCB in soils (40 CFR Part 761.1) based on documented research and development documents. The 10 ppm Illinois criterion is not justified other than saying it is a response criterion. Is it a cleanup level or simply to initiate remedial investigation? How is it justified? It seems that the 50 ppm EPA level for cleanup is much better established. Furthermore, if site access were restricted the allowable level of organic contaminants could be increased as the mechanism of skin and eye irritation would be controlled. In addition, the statement that background soil concentrations will be low to nil seems subjective. As demonstrated previously, background levels could exceed recommended soil criteria.

The suggested 1 ppm cyanide level in soils also requires documentation. Recent work by EPA's Environmental Criteria and Assessment office regarding cyanide levels in sewage sludge for land application indicate cyanide levels are not a problem and are biodegradable in the soil environment.[5] To date a suggested level has not been established but it will likely be orders of magnitude above 1 ppm.

Objective No. 6:

Maintain ambient air quality. The FS proposes to employ ambient air levels of 1/300th and 1/50th of the 8-hour threshold limit values (TLV) for high and low toxicity compounds respectively. Table 9 of the FS notes the category each constituent is placed into. These levels are recommended for constant exposure.

Discussion:

E. A. Hickok did not review the source of this recommended guideline. However, the data base upon which this guideline was developed is without toxicity studies and relies on general factors of safety to develop these limits.[3] The use of such stringent criteria may preclude the use of certain treatment techniques such as air stripping.

Summary of Response Criteria Discussion:

Many of the criteria proposed are based on guidelines which are not well established or may not be applicable in this specific situation. In some cases criteria conflict with known background concentrations and well founded national standards. Furthermore, justification for draft PPLC's over ACL's is not established. The establishment of soil concentrations based on skin and eye irritation should be reconsidered as this mechanism of health impairment will be controlled.

2.3 Initial Screening of Alternatives

Several alternatives analyzed in the FS report were determined to be not feasible or unjustified during the preliminary screening of alternatives. Table 3.3, taken from Table 11 of the FS report and edited, summarizes this work. Treatment/removal techniques which have been used in conjunction with other contamination sites and which were judged not feasible are land farming, biodegradation and flushing. The FS discussion presented on land farming is very brief and states that due to the highly volatile nature of the chemical contaminants and large quantities of material on-site it is not appropriate. Similarly the discussion on in-situ biodegration and flushing concludes this process is not feasible due to extensive contamination.

The FS examined several alternative methods of supplying drinking water to off-site receptors. New deeper wells downgradient of the ACME site were screened out of the alternatives because "it is likely such wells would either become contaminated with use or completed in an existing contaminated zone."(2) It is also implied that the new deep well at Pagel's Pit may become contaminated in the future.(2)

Discussion:

The soil boring program conducted by Jordan during the RI work established the approximate horizontal extent of contaminated soils at the ACME site. Split spoon samples were not obtained deeper than 2 feet in any boring so the vertical distribution of contaminants below 2 feet in the unsaturated zone is not

TABLE 3.3

PRELIMINARY SCREENING OF ALTERNATIVES[1]

Category	General Technology Heading	Specific Technology	Feasibility Status
Avoidance			
	Receptor Relocation	--	Not Justified
	Development of Individual Water Supplies		
		Home Water Treatment Units	Feasible
	Development of Community Water Supplies		
		Development of New Well	Feasible
		Obtain Rights to Existing Well	Not Feasible
	Extension of Existing Water Supply		
		Rockford	Not Feasible
		Stillman Valley	Not Feasible
		Morristown Trailer Park	Not Feasible
	Site Fencing		Feasible
Containment			
	Site Capping		Feasible
	In-place Vitrification		Not Feasible
	Solidification/Fixation		Feasible with Restriction
	Storage		Not Feasible
	Collection Drains		Feasible with Restriction
	Barrier Walls		Not Feasible
	Grouting		Feasible
	RCRA Approved Facility		Feasible
Removal			
	Excavation and Trucking		Feasible
	Land Farming		Not Feasible
	Flushing (Leaching)		Not Feasible
Treatment			
	Air-Stripping	Packed Tower	Feasible
	Activated Carbon	Packed Column	Feasible
	Reverse Osmosis		Not Feasible
	Oxidation		Not Feasible
	In-Situ Biodegradation		Not Feasible
	On-Site Land Disposal		Feasible
	Off-Site Land Disposal		Feasible
	Incineration	On-Site	Feasible
		Off-Site	Feasible
	Pyrolysis		Not Feasible

(1) Compiled and edited from Table 11 Ref. #2.

documented. The FIT project report by a U.S. EPA contractor did not analyze soil samples either.[4] Sixteen (16) soil borings were advanced and detailed logs are presented in the FIT report appendices. None of the boring logs on the ACME site noted the presence of chemical contamination, odors, staining, etc., in the surficial soils. Test pits were constructed during the RI work in areas suspected of having waste deposits and several areas of contamination were located. It is highly probable that soil contamination drops significantly with depth. If grossly contaminated soils and sludge deposits were removed/treated by some other technology, moderate to low contaminated soils would be a good candidate for land farming, flushing or biodegradation. The fact that many of the contaminants are volatile and/or soluble makes land farming and flushing of low or moderately contaminated soils suitable treatment methods. If air discharges remain below established air quality criteria these treatment methods may be an excellent alternative. Air stripping and carbon adsorption could also be employed in conjunction with these processes if necessary.

Biodegradation of soil contaminants may also be suitable in low to moderately contaminated soils. It is our opinion that the limited soil sampling data collected to date may not justify the excavation and removal of 26,000 cubic yards of material. The RI/FS work does not correlate sampling data with the 26,000 cubic yard excavation estimate.

The conclusions regarding deeper aquifer contamination are justified on the basis of a single groundwater sampling event and limited data on the deeper aquifers presented in the FS report.

2.4 Remedial Alternative Technologies Considered

After preliminary screening the alternative components shown in Table 3.4 remained for further consideration. These components were assembled into various alternatives, costed and evaluated. Each component was also evaluated

TABLE 3.4

ALTERNATIVE COMPONENTS CONSIDERED

Category	General Technology Heading	Specific Technology
Avoidance		
	Development of Individual Water Supplies	Home Water Treatment Units
	Development of Community Water Supplies	Development of New Well
	Site Fencing	
Containment		
	Site Capping	
	Collection Drains	
	Grouting	
	RCRA Approved Facility (Landfill)	
Removal		
	Excavation and Trucking	
Treatment		
	Air-Stripping	Packed Tower
	Activated Carbon	Packed Column
	Land Disposal	On-Site
	Incineration	On-Site Off-Site

in general during the preliminary screening process. Components were evaluated for technical feasibility, cost and environmental/institutional concerns. Certain restrictions were placed on various components. For example collection drains were limited to leachate collection from a RCRA facility (landfill) with an underlying liner system. General operating and maintenance criteria were also discussed.

2.4.1 Avoidance

Both home water treatment units consisting of two carbon columns in series and a new community well were selected for further analysis. The purchase of water from the new Pagel's Pit well completed in the St. Peter sandstone was dropped for two reasons. The owners were not willing to allow connections by local residents and Jordan indicates that this well may be contaminated in the future. Site fencing was selected for further consideration as an avoidance technology.

Discussion:

The comments on contamination of new Pagel's Pit well are not supported by data presented in the feasibility study.

2.4.2 Containment

Four containment components were considered for alternative remedial actions. They are site capping, the use of collection drains, bedrock grouting and RCRA approved land disposal. Site capping was considered for management of wastes on-site. It was characterized in the FS as a "commonly employed" and "highly implementable" technique.(2) The purpose of capping is to limit the movement of contaminants from the site. It was estimated 6.5 acres of the site require capping.

Collection drains would require the placement of a liner since site soils are permeable. These drains would likely be of service for leachate collection and control.

High pressure block grouting of the upper bedrock is developed in detail. It is noted there are no solution cavities or caverns in the bedrock and that the grouted bedrock requires little if any maintenance. Block grouting would be conducted over 3 acres of land currently overlain by waste deposits.(2)

A RCRA permitted land disposal site at the ACME facility is stated to be of questionable practicality. Permit requirements, regulatory agency philosphy and concerns are mentioned as potential problems. It is stated that the regulatory agencies may not "consider the landfill with the intent of RCRA primarily because the site is underlain by relatively permeable soil and bedrock and vulnerable groundwater resources."(2)

Discussion:

The FS presentation of block grouting discussion requires further examination. The bedrock coring samples collected by the FIT contractor indicated weathered bedrock conditions, numerous fractures, lost cores, etc. Corings B-2 and B-4 within the ACME site boundaries show rock quality designation (RQD) from 0% to 80%.(4) This RQD percent range is rated from very poor (0-25%) to good (75-90%). Many RQD values were in the very poor to poor category (0-50%).(6) Coring B-2 shows a 13% RQD 40 feet into the bedrock surface. Grouting only 25 feet deep in this area may not be effective. Based on this data, the assumptions of block grouting should be re-examined. The assumption of little or no maintenance is not well justified or documented. It seems questionable that bedrock grouting to the extent noted will be effective in blocking vertical or horizontal flow. Another point regarding this subject is the area to be grouted. A 3-acre area is mentioned in the FS while capping would be required for a 6.5 acre area. Similar or larger figures would normally be expected for bedrock grouting. Usually, contaminants will migrate with vertical and horizontal directional flow components so if capping is required over 6.5 acres, grouting should be required over an area at least as large.

In spite of agency philosophies and concerns landfills are regulated under the RCRA program. Sites with permeable soils and vulnerable groundwater resources are not disqualified from obtaining a permit. However, it is true that costly safeguards (double liners, leachate collection systems, etc.) would be required. Given recent actions by State and Federal regulatory agencies and the enactment of the Hazardous and Solid Waste Amendments of 1984, these safeguards are, or will be, required anywhere.(7)

2.4.3 Removal

Excavation and trucking was evaluated as the single removal technique. Land farming and flushing were dropped based on preliminary screening. Approximately 27,000 cubic yards of material and 10,000 overpack drums were used to compile cost estimates for this technique.

Discussion:

The 27,000 cubic yard estimate required for excavation is not documented in the FS.

2.4.4 Treatment

Air stripping and activated carbon treatment employed with groundwater extraction were selected with land disposal and incineration for further analysis as treatment techniques. The FS concentrated on removal of volatile organics from groundwater since "significant quantities of semi-volatile compounds have not been detected in groundwater."(2) It is noted where drinking water quality is not required, air stripping is economically preferable to activated carbon. No factors have been identified on the ACME site which interfere with air stripping efficiency except possibly with multiple stripping towers. Activated carbon has a limited adsorption potential for chemicals present in the groundwater and carbon replacement would have to be undertaken frequently. Land disposal was determined to be feasible off-site although certain waste characteristics (ignitability and the presence of PCBs) may limit the number of disposal sites.

Incineration either on or off-site is feasible for wastes and contaminated soils at the ACME site. Jordan notes however that incineration is "technically complex and expensive." Two types of incineration technology were examined; the rotary kiln and the infrared furnace. Both technologies are capable of 99.99 percent destruction of the wastes. Ash disposal in a RCRA-approved facility may be required.

Discussion:

The infrared incineration technology is a relatively new application for waste disposal and does not have the proven record of rotary kiln technology. Other incineration technologies such as the fluidized bed may be very effective in treating sludges, wastes, and contaminated soils but were not evaluated. A survey of 28 fluidized bed manufacturers indicated that 22 had the capability of treating liquid wastes and sludges in conjunction with other fuels.[8] Recently, a modified asphalt drying system has been used to successfully treat moderately contaminated soils.[9] This technique uses a low temperature dryer with a long contact time to volatilize and oxidize organic compounds. It was reported to achieve greater than 99 percent removal. An asphalt drying system is available adjacent to the ACME site at Rockford Blacktop. In summary, it appears the incineration or thermal treatment options were narrowed either prematurely or without proper jusitification.

2.5 Selected Remedial Alternatives

The FS report developed several alternatives using the components discussed previously. Table 3.5 summarizes the alternatives examined in detail in the FS. The effectiveness ranking system (discussed previously) is also developed

TABLE 3.5

LIST OF ALTERNATIVES FOR DETAILED EVALUATION(1)

1. No Action.

2. Site Capping and Monitoring.

3a. Soil and Drum Excavation, Off-Site Land Disposal (RCRA Approved Facility) and Bedrock Grouting.

4a. Soil and Drum Excavation, Off-Site Incineration and Bedrock Grouting.

5a. Soil and Drum Excavation, and On-Site Land Disposal (RCRA Approved Facility) and Bedrock Grouting.

6a. Soil and Drum Excavation, On-Site Incineration and Bedrock Grouting.

6b. Soil and Drum Excavation, On-Site Incineration, Bedrock Grouting and On-Site Ash Disposal in a RCRA Approved Facility.

7a. Soil and Drum Excavation, On-Site Land Disposal of Soils (RCRA Approved Facility), and Off-Site Land Disposal of Drums (RCRA Approved Facility) Bedrock Grouting.

8a. Soil and Drum Excavation, On-Site Incineration of Soils, Off-Site Land Disposal of Drums (RCRA Approved Facility), and Bedrock Grouting.

8f. Soil and Drum Excavation, On-Site Incineration of Soils, Off-Site Land Disposal of Drums (RCRA Approved Facility), Bedrock Grouting and On-Site Ash Disposal in RCRA Approved Facility.

OFF-SITE REMEDIAL ALTERNATIVES

2. Installation of Home Water Treatment Units.

3. Development of Upgradient Well and New Community Water Supply System.

4a. Groundwater Extraction and Treatment with Air-Stripping.

4b. Groundwater Extraction and Treatment with Activated Carbon.

5a. Groundwater Extraction and Treatment with Home Water Treatment Units.

5b. Groundwater Extraction and Treatment with Installation of Upgradient Wells and New Community Water Supply System.

(1)All information taken from reference no. 2, Table 18.

in this section of the FS report and results are reported starting on page 5-100.[4] Separate effectiveness scores for on-site and off-site alternatives were developed. Table 3.6 summarizes these scores.

The FS report leaves open the question of the recommended remedial action(s). If all response objectives are to be met, on-site option 6a is most cost-effective. If objective no. 7 is dropped, then land disposal is more cost-effective. Recommended off-site alternatives include the use of home water treatment units and groundwater extraction.

Discussion:

The effectiveness ranking has been previously described as subjective. For instance, the 'No Action' alternative with a ranking of 34 has approximately 50 percent of the on-site incineration alternative yet regulatory agencies would certainly not consider 'No Action' half as effective as on-site incineration. Response Objective No. 7 which is not justified enters into the cost-effective analyses and leads the FS contractor to conclude on-site incineration is most cost-effective if the objective is to be met. Meeting this objective also requires the selection of an alternative (6a) with a lower effectiveness scoring of 66.5 than off-site land disposal (alternative 3a; 74 points) with a lower overall cost (see Table 2A).

2.6 Further Discussion of Remedial Alternatives

2.6.1 On-Site Alternative 1 - No Action

A computer-based model was used to simulate the 'No Action' alternative. The model does not account for vertical flow components which are mentioned several times to exist and supposedly are the reason for deeper aquifer contamination and potential contamination. The plume from Pagel's pit is not simulated either. The model predicts improvement in groundwater quality with source

TABLE 3.6

EFFECTIVENESS SCORING SUMMARY(1)

Alternative No.	Description	Total Effectiveness Score
	On-Site Alternatives	
1	No Action	34
2	Site Capping	49
3a	Off-Site Land Disposal	74
4a	Off-Site Incineration	78
5a	On-Site Land Disposal	49
6a	On-Site Incineration	66.5
6b	On-Site Incineration Ash Disposal	64
7a	Soil Disposal On-Site, Drums Off-Site	53
8a	On-Site Soil Incineration, Off-Site Land Disposal of Drums	64
8b	8a + Ash Disposal On-Site	63.5
	Off-Site Alternatives	
2	Home Water Treatment Units	66
3	Community Water Supply	61
4a/4b	Groundwater Extraction and Treatment	66.5
5a/5b	Groundwater Extraction and Alternative Water Supply	78

(1)All data from reference no. 2, Tables 37 and 38.

removal. No action was simulated using a constant source recharge to the groundwater under the site of 4 mg/l[2] for total volatile organics. A derivation or discussion of assumptions used to arrive at this recharge rate is not presented in the RI or FS documents. Table 3.7 is a comparison of this assumption with actual groundwater quality data at the ACME site.

TABLE 3.7

	Total Volatile Organics (mg/l)	Total Number of Wells
Recharge Rate Assumed by Jordan	4.0	NA
Mean Value of Acme Monitoring Wells(1)		
Shallow - All Wells	0.580	7
Shallow Wells Excluding B-4	0.038	6
Intermediate Wells	--	3
Deep Wells	0.021	3
Unknown Depth	0.038	2
All Acme Wells	0.280	15
All Acme Wells Excluding B-4	0.026	14

(1)Definition of shallow, intermediate, and deep wells is described in Reference 11.

Based on the data in Table 3.7, the model of recharge rate assumption appears to be high. Predicted values at the various monitoring wells were not presented in the FS. However, data does exist to calibrate the model and it is not stated whether an attempt was made to accomplish this. An interesting potential contrast to the model is the findings in the RI that groundwater quality off the

ACME site has improved when compared to the FIT report data.[1][4] This suggests the No-Action model is probably not accurately predicting off-site groundwater contamination levels. The model predicts unacceptable drinking water quality off-site for 100 years; however, the RI report states, "based on the present concentrations of VOCs in the domestic wells, these chemicals do not pose a threat to human health in terms of the recommended limits for specific chemicals established by the U.S. EPA." (Reference No. 1, page 86).

2.6.2 On-Site Alternative 1 - Site Capping and Monitoring

The FS reports recommends the development of ACLs in conjunction with this alternative. We strongly agree this should be accomplished.

2.6.3 On-Site Alternative 3 - Soil and Drum Excavation, Off-Site Land and Bedrock Grouting

Waste excavation is estimated to require the removal of approximately 26,000 cubic yards of material from the ACME site. This includes 10,000 drums reportedly buried on-site. It is stated that two landfill facilities located in Ohio and New York could accept all materials from the ACME site, and one landfill located in Illinois could accept the majority of materials from the site. The bedrock grouting program is estimated to cover three acres, consisting of 450 grout holes, approximately 25 feet deep. No maintenance is anticipated for the grouted bedrock, but it is stated that contaminants could be remobilized by seismic-induced fractures or leaching due to a rise in the groundwater table. No mention is made during this discussion of the bedrock quality or the use of the FIT contractor drilling information provided in reference no. 4.

2.6.4 On-Site Alternative 4a - Soil and Drum Excavation, Off-Site Incineration, and Bedrock Grouting

A vendor's hazardous waste incineration system located in Chicago was used to estimate the cost of this alternative. The incinerator accepts a full range of materials. The vendor assumes full responsibility for compliance with environmental standards including ash disposal. This alternative achieves the highest degree of compliance with response objectives. However, it is also the most costly by far of any of the alternatives examined.

2.6.5 On-Site Alternative 5a - Soil and Drum Excavation, On-Site Land Disposal, and Bedrock Grouting

This alternative includes development of an on-site RCRA landfill using a double synthetic liner system and leachate collection system. The landfill area is estimated as approximately three acres in area and ten feet deep in section. This would provide approximately 30 acre-feet of landfill capacity. This volume seems conservative when calculating the 26,000 cubic yards to be removed would occupy a space of approximately 16 acre-feet. It is stated in the FS that the Illinois State Geological Survey has indicated the site is unsuitable for landfill development and that the site does not generally comply with "accepted hazardous waste landfill siting criteria."[2] It should be noted that the RCRA Regulations 40 CFR Part 264 require performance standards for hazardous waste landfills and do not require location standards (excepting seismic standards). Although it is not specifically stated, the comments of the Illinois State Geological Survey probably are directed at sanitary landfill operations. We do not wish to imply that this is an ideal RCRA landfill site; however, it may be a developable site based on current RCRA regulations.

2.6.6 On-Site Alternative 6a - Soil and Drum Excavation, On-Site Incineration, and Bedrock Grouting

Two types of on-site incineration systems were evaluated: rotary kiln and infrared furnace. The text of the FS report notes that "evaluation of on-site incineration is primarily limited to infrared furnace technology because the names of clients using rotary kiln technology were not furnished by vendors." Past operating practices of the infrared incineration system cited in the FS report consisted of an operation in New York state; however, the down time for this operation approximated 30 percent. It was further noted that highly volatile wastes caused widely fluctuating temperatures and increased the amount of operation and maintenance required for the unit. The vendor indicated that he expects significantly less down time at the ACME site. It seems that a continuous operation with a constant type of waste material would be much easier to operate with than the varied wastestream encountered at ACME. The use of this incineration system at a facility similar to that which would handle wastes from the ACME site has not been documented. Conversely, rotary kiln systems have been successfully used for varied wastestreams and have a long history of use.

2.6.8 <u>On-Site Alternative 6b - Soil and Drum Excavation, On-Site Incineration, Bedrock Grouting, and On-Site Ash Disposal in an Approved RCRA Facility</u>

This alternative is the same as Alternative 6a with the exception that an on-site landfill is included for ash disposal in the event that the incinerator ash may be considered a hazardous waste.

2.6.9 <u>On-Site Alternative 7a - Soil and Drum Excavation, On-Site Land Disposal of Soils, Off-Site Land Disposal of Drums and Bedrock Grouting</u>

This alternative is similar to Alternative 5a except that soils are handled on-site. On-site construction will include the use of a RCRA hazardous waste landfill to contain contaminated soil. Drums and drum contents would be excavated and taken to a site better able to handle this type of waste.

2.6.10 <u>On-Site Alternative 8a - Soil and Drum Excavation, On-Site Incineration of Soils, Off-Site Land Disposal of Drums, and Bedrock Grouting</u>

This alternative is also a variation of previous alternatives. Drums will be excavated and will be taken to an existing off-site land disposal facility. An on-site incinerator will be used to decontaminate soils on the ACME site.

2.6.11 On-Site Alternative 8f - Soil and Drum Excavation, On-Site Incineration of Soils, Off-Site Land Disposal of Drums, and On-Site Ash Disposal

This alternative is the same as Alternative 6b except that it provides for off-site disposal of excavated drums.

2.6.12 Off-Site Alternative 2 - Installation of Home Water Treatments

Home water treatment units would be supplied to affected and potentially affected residences in the area of the ACME facility. These systems consist of carbon columns in series which can be rotated and used in conjunction with the existing private well system. Approximately 16 homes would be provided with this system. These types of systems are available from several vendors and have been used in similar instances in the past.

2.6.13 Off-Site Alternative 3 - Development of New Well and Community Water Supply System

This system would be constructed to serve the 16 potentially affected homes near the ACME site. A new 10-inch diameter well approximately 150 feet deep would be constructed. A hydropneumatic storage system would be employed to pressurize the system and equalize flow. The estimated total present worth cost for this system is slightly less on a present-worth basis than the cost for the home treatment units. However, the effectiveness assigned to this alternative is lower than that of the home water treatment units because it does not abate short-term environmental effects (Reference (2), Table 38). However, test data in the RI/FS Report notes that groundwater quality does not now "pose a threat to human health in terms of the recommended limits for specific chemicals established by EPA." (Reference 1, page 86).

2.6.14 Off-Site Alternatives 4a and 4b - Groundwater Extraction and Treatment

A series of computer runs were made to develop contaminant distribution data around and near the ACME site. The same model used during the evaluation of the 'No Action' alternative was employed to evaluate this alternative. Although not stated, it is probable that the same recharge rate of volatile organics was used.

Vertical flow components which have been noted many times as a source of concern by the FS contractor were not considered in this model. Therefore, any conclusions regarding a deeper aquifer or vertical distribution of contamination cannot be used. The model indicates that area wells will continue to be affected for some time unless a groundwater extraction program is employed. This conclusion conflicts with current data collected by the FS contractor during the remedial investigation. This was discussed previously under the 'No Action' alternative, Section 2.6.1.

To evaluate groundwater extraction, five wells were positioned to intercept the plume from the ACME site. Pumping rates of 0.1, 1.0, and 10 mgd continue to be evaluated using the computer model. The 10 mgd rate was later dropped as it was found not practical for the physical conditions existing in the upper aquifer. Through modeling, it was determined that the optimum removal rate was between 0.5 and 2 mgd; therefore, the 1 mgd alternative would be the most effective for this situation. Recent work by E. A. Hickok indicates that an upgradient source of groundwater contamination is likely.[11] This development when considered with the Pagel's Pit discharge and data presented in Table 3.7 of this memorandum indicate that groundwater extraction and treatment should be reconsidered. The model should be calibrated and the assumed total volatile organic recharge rate re-examined. Treatment of the extracted groundwater may be necessary depending on the discharge requirements of water quality.

Two types of treatment were evaluated: activated carbon and air stripping. It was noted that air stripping could be used effectively on the site without affecting downwind receptors.

2.6.15 Off-Site Remedial Alternatives 5a and 5b - Groundwater Extraction, Treatment and Establishment of Alternative Water Supplies

This alternative combines the groundwater extraction and treatment alternative with alternative water supplies for the 16 potentially affected homes.

3.0 CONCLUSIONS

1. Response objective no. 7 in the FS does not conform to 40 CFR 300.68(h) requirements.

2. The use of PPCL data for groundwater response criteria in lieu of ACL criteria is not justified in the FS. This may ultimately impact the consideration of certain remedial actions.

3. The use of soil criteria based on skin and eye tissue irritation is questionable since even the 'No Action' alternative would limit potential exposure through these mechanisms. Furthermore, standards below suspected background levels and federal standards are recommended in the FS report.

4. Air quality criteria have been developed based on constant exposure using guidelines developed without exposure studies.

5. The estimate of 26,000-27,000 cubic yards of soil requiring removal or treatment is not documented in the FS. Similarly, conclusions regarding deeper aquifer contamination are not documented.

6. Bedrock grouting assumptions are not well supported by the coring work accomplished by other contractors. The effectiveness of this technique as presented appears questionable.

7. Air stripping was judged to be suitable for volatile organic removal at the ACME site.

8. Infrared incineration (the selected technology) estimates are based on an industrial facility treating a single wastestream.

9. The effectiveness ranking system developed in the FS relies on subjective rather than quantitative criteria. The consideration of this system results in the selection of remedial action(s) which are not the most cost-effective.

10. The groundwater model used to simulate various alternatives did not consider vertical gradients or the effects of off-site contamination. Results did not compare well with the current groundwater quality data. The volatile organic recharge rate selected was not justified and it is not stated whether or not the model was calibrated with existing data.

REFERENCES

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3. Personal communication with Ed Anna, New York State Department of Environmental Conservation, Albany, New York, February 28, 1985.

4. Field Investigations of Uncontrolled Hazardous Waste Sites, ACME Solvents, Pagel's Pit area by Ecology and Environment, Inc., for the United States Environmental Protection Agency, March, 1983.

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10. <u>Review of QA/QC Program for Remedial Investigation of ACME Solvents Disposal Site</u> by E. A. Hickok and Associates, March 1985.

11. <u>Review of Groundwater Monitoring Data for Remedial Investigation of ACME Solvents Superfund Site</u> by E. A. Hickok and Associates, March 1985.

RECOMMENDATIONS

RECOMMENDATIONS

Based on our review of the Remedial Investigation/Feasibility Study, Eugene A. Hickok and Associates, Inc. recommends that a group of alleged potentially responsible parties take the following steps concerning the voluntary cleanup of the Acme site.

In logical sequence, the first major remedial activity addressed in the RI/FS is the removal of drummed and containerized wastes estimated to total 10,000 drums. It is recommended that this remedial activity be carried out and suggested that before it is implemented, additional investigation be conducted through an additional magnetometer study and/or other methods. The additional investigation would more exactly delineate the location of buried, containerized waste material.

Before proceeding with additional remedial steps at the site, Eugene A. Hickok and Associates, Inc. believes it is essential to fill in gaps in data collected to date, to resolve conflicts in some information at hand, and to obtain additional data to answer several unanswered questions or to provide support for a number of unproven postulates. Unless these steps are accomplished, Eugene A. Hickok and Associates, Inc. believes it will be impossible to say that any additional remedial actions will be efficient and effective or will be appropriate under the National Contingency Plan.

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